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# THE AMERICAN JOURNAL OF PSYCHOLOGY

Founded by G. STANLEY HALL in 1887

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VOL. XXIV

JULY, 1913

No. 3

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## THE RÔLE OF KINAESTHESIS IN THE PERCEPTION OF RHYTHM<sup>1</sup>

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### I. INTRODUCTION

The experimental investigation of the perception of rhythm has grown so extensive and, at the same time, so indefinite in scope that the writing of an introduction which shall be adequate to the general problem is now altogether out of the question.<sup>2</sup> The subject of rhythm has been carried over into many fields both inside and outside of the science of psychology: within, it has been related to attention, work, fatigue, temporal estimation, affection, and melody; without, it is fre-

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<sup>1</sup> From the Psychological Laboratory of Cornell University.

<sup>2</sup> We expect to publish a complete bibliography on the subject of *rhythm* in the next number of this *Journal*.

quently mentioned in connection with music, literature, biology, geology, gymnastics, physiology, and pedagogy. If we follow out its progress within the range of psychological investigation, we find, again, an intricate plexus of results, theories, and issues. Emphasis has been laid on various component factors of consciousness involved in the perception of rhythm: changes of affective processes; effect of pitch, of duration, of intensity of stimulus on rhythmic perception; types of possible rhythmic perception; part played by different modalities of imagery; bases for rhythmic grouping and accentuation. An adequate summary of the work done even in this limited field would fill a fairly large monograph.

It is now, furthermore, no longer possible to undertake a set of experimental investigations, as was done twenty years ago,<sup>3</sup> to cover the entire range of the perception of rhythm. Attacks directed at the problem from various points of view, and with various methods of procedure, are the run of the day. No one, as far as the literature tells, has since that time attempted to make a complete study of rhythm.

*A. Historical.*—There seems to be one factor, however, which, when singled out and brought into perspective with other factors, has been assigned a prominent place in the discussion of rhythm. It would not be permissible to say that this factor has itself been the subject of discussion, for, curiously enough, it has often been taken for granted,—regarded, as it were, from an established point of view. Kinaesthesia of one sort or another, or motor expression consciously represented in the form of imagery or perceptual complex, is regarded by most investigators in this field as essential to rhythmic grouping and accentuation; it is considered, by a few, as non-basic but contributory and perhaps, indeed, as jointly essential; it is not mentioned at all by a few others. The point is, however, that the last class of investigators do not enter the lists polemically against those who emphasize the presence of the kinaesthetic component in the perception of rhythm. They simply advance a theory which turns out to be different.

Meumann comes to the conclusion that rhythms are perceived as the result of a mental activity conditioned either by the temporal quality of the perception or by the unitariness of meaning logically superimposed upon the impressions perceived. He says:

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<sup>3</sup> Cf. Bolton, T. L. Rhythm, this *Journal*, 6, 1894, 145-238.

In every case of rhythmical perception we group the isolated sensations of sound into a more or less complex system of ideas that are temporally arranged.<sup>4</sup>

For some observers the combining of the impressions is at the same time a temporal concatenation in the sense that the members of a group appear to follow one another more quickly, while a pause is experienced between every two groups.<sup>5</sup>

The other form of grouping is typified by the following quotations:

This process of grouping was recalled and described to me by my observers as an '*inner combination*'; the single beats were taken out of their incipient isolation and appeared as parts of a whole; the groups, on the other hand, were clearly separated one from another.<sup>6</sup>

The peculiarity of the whole experience of rhythm, it seems to me, is its *pure central initiation*. Either the reproduction of familiar meters, or better, perhaps, the *unequal distribution of the energy of attention* must be considered in this connection.<sup>7</sup>

But the course of 'thoughts' becomes itself the condition of rhythmisation. The character of the entire rhythm is preëminently determined by this delimitation of meaning. The groups which appear collectively to the ear (and, in this sense, the rhythmical units) are constituted as a kind of rhythmical treatment, which is peculiarly characteristic of Goethe's lyric verse.<sup>8</sup>

Woodrow, in closing the summary of his experimental work, also emphasises the temporal aspect of rhythmical grouping:

This close correspondence between the rhythmical grouping and the temporal grouping, or rather this correspondence in the points where both disappear, indicates that rhythmical grouping is a temporal grouping; that is, that rhythmical grouping is determined by the duration of the subjective intervals, not by the objectively measurable intervals, but by the subject's consciousness of these intervals, that is, by the intervals considered as mental magnitudes.<sup>9</sup>

Continuing to consider these classes of authorities in an inverse order, we find a group who conclude that kinaesthesia is a factor which is jointly essential to the perception of rhythm. Wundt, for example, gives a genetic explanation for rhythm in terms of the movements of locomotion, and then makes the essential characteristic of rhythmical perceptions dependent upon the changes in the course of affection, with a motor tendency in the background of consciousness:

<sup>4</sup> Meumann, E. Untersuchungen zur Psychologie u. Aesthetik d. Rhythmus, *Philos. Stud.*, 10, 1894, 283.

<sup>5</sup> *Ibid.*, 304.

<sup>6</sup> *Ibid.*, 303.

<sup>7</sup> *Ibid.*, 304.

<sup>8</sup> *Ibid.*, 396.

<sup>9</sup> Woodrow, H. A quantitative study of rhythm, New York, 1909, 66.

So we have every reason to consider the movements of locomotion as the natural origin of rhythmical perceptions.<sup>10</sup>

Consciousness is rhythmically disposed, because the whole organism is rhythmically disposed. The movements of the heart, of breathing, of walking, take place rhythmically. . . . Above all, the movements of walking form a very clear and recognisable background to our consciousness.<sup>11</sup>

Pleasure and displeasure constitute, as we saw above, subordinate forms of rhythmic affections which, because they parallel in a relative equivalence the peculiar contents of pleasure and displeasure, we can designate as *formal* components of the aesthetic effect of feelings. In contrast to this, the characteristic *contents* of rhythmical effect results from the *specific form of rhythmical movement* which is, in turn, capable of very numerous gradations and in which varying mixtures of different components of affection and changes between qualitatively differing and, indeed, opposed affections, are possible. Because, at the same time, this contents always partakes of a certain affective character, we can contrast with it that formal or abstract affective quality of pleasure and displeasure under the concept of the *affective* components of rhythm.<sup>12</sup>

In essentials Stumpf does not disagree with Wundt in this notion of the factors which are important in rhythm:

Judgments of time and intensity are further connected in the comprehension of rhythm; this we shall best discuss, however, in connection with the theory of affection.<sup>13</sup>

It looks, indeed, as if our sense of rhythm and time was essentially developed in connection with the movements of locomotion.<sup>14</sup>

Ebhardt assigns to a number of factors the responsibility of giving rise to rhythmical phenomena, but lays most stress on the importance of affective tone:

The following assumptions were made as hypothetical explanations of these phenomena: peculiarities of motor action, change of direction of attention, and the combination of members into groups or the separation of groups in the process of comprehension and in the process of execution corresponding to it.<sup>15</sup>

This affective tone, it appears to me, forms an essential component of rhythm; it must be present if there is not to be a failure to comprehend the rhythm: the player would miss something if he could not successfully arouse and maintain an affective contents.<sup>16</sup>

But by far the greater number of investigators and systematic writers on the subject of rhythm emphasise the primary

<sup>10</sup> Wundt, W. *Grundzüge d. physiologischen Psychologie*, 6th ed., 1911, vol. III, 32.

<sup>11</sup> Wundt, W. *Introduction to psychology* (trans. Pintner), New York, 1912, 5.

<sup>12</sup> *Grundzüge*, vol. III, 147.

<sup>13</sup> Stumpf, C. *Tonpsychologie*, Leipzig, 1883, vol. I, 135.

<sup>14</sup> *Ibid.*, 340.

<sup>15</sup> Ebhardt, K. *Zwei Beiträge zur Psychologie d. Rhythmus u. d. Tempo*, *Zeits. f. Psychol.*, 18, 1898, 127.

<sup>16</sup> *Ibid.*, 140.

importance of kinaesthesia and of motor response in rhythmical perceptions. Whether this motor response is consciously represented, a few of these writers do not specify, but the majority use the phrase as an equivalent for kinaesthesia. Taken up in historical order, we find Bolton, the pioneer American investigator, making the statement:

We come now to the subject of muscular movements and their relation to rhythm. Most subjects felt themselves impelled by an irresistible force to make muscular movements of some sort accompanying the rhythms. If they attempted to restrain these movements in one muscle, they were likely to appear somewhere else. . . . The question we have to decide is, are these muscular movements and associations the result or the conditions of the rhythmical grouping? With Ribot we accept without hesitation the latter. . . . Each impression as it enters into consciousness tends to find expression in a muscular movement, but the intensive changes in the series of impressions produce corresponding changes in the intensity of the sensations, which must find expression in different degrees of muscular activity. In order to express these different degrees of sensation, the muscular movements must rise above the merely nascent state in which they ordinarily occur, and manifest themselves in visible muscular movements.<sup>17</sup>

Ettlinger, while working and theorising more about the aesthetical aspect of rhythm, says:

The descending grouping of two elements [trochee] represents, therefore, the transition from a period of rest to a period of advance, the initiation of a movement. If such a group stands at the beginning of a series, then it indicates with especial clearness the origin of a movement. Outside of this, inasmuch as there is no return to a period of rest to be found in it, it points on this account to a perpetuation of the movement. When, therefore, it appears at the end of a movement, it does not bring that movement definitely to completion, but allows it to be dissipated in empty space.<sup>18</sup>

MacDougall accounts for the temporal element in rhythmical perception on the basis of organic activity and of kinaesthesia:

The fundamental conditions of the rhythm experience are therefore to be looked for in the laws of periodicity of functioning in the bodily organism. It is because these processes take place under conditions of regularly recurrent change that the time element becomes important in rhythmical sequences.<sup>19</sup>

Elsewhere, in much the same manner, he describes the effect of mechanical conditions imposed on the expression of rhythm by processes of muscular contraction and release.<sup>20</sup>

<sup>17</sup> *Op. cit.*, 234.

<sup>18</sup> Ettlinger, M. Zur Grundlegung einer Aesthetik d. Rhythmus, *Zeits. f. Psychol.*, 22, 1900, 186-7.

<sup>19</sup> MacDougall, R. The relation of auditory rhythm to nervous discharge, *Psychol. Rev.*, 9, 1902, 465.

<sup>20</sup> The structure of simple rhythm forms, *Monog. Suppl., Psychol. Rev.*, 4, 1903, 327.

Speaking of kinaesthesia, Miner, who has made a special study of motor rhythms, concludes:

I believe it is time to recognise that it is this element in the conscious experience which adequately affords the explanation of the main fact of rhythm,—the group feeling. To be sure we do not stop here. There are many other attributes of the rhythmic impression to be accounted for. . . . The advantage of the kinaesthetic thesis which is here offered is that it gives a satisfactory mode of approach for these other problems.<sup>21</sup>

Stetson, under the heading, *Suggestions for a motor theory of rhythm*, opens a discussion of the motor theory as applied to rhythmical perceptions with the words:

If the basis of rhythm is to be found in muscular sensations, rather than in the supposed activity of some special 'mental' function, the nature of the movement cycle involved is of greatest interest.<sup>22</sup>

And he concludes:

Assuming such a movement cycle, in which the tension between the two opposing sets never comes to zero until the close of the series, it is not difficult to arrange many of the facts of rhythmic perception under the motor theory.<sup>23</sup>

One of the six conclusions, drawn by Koffka as the result of experimental investigations, reads:

Motor imagery has, however, the greatest significance for rhythmical experiences. It appears almost universally, and is, for the most part, very difficult to suppress.<sup>24</sup>

Agreeing, in the main, with Stetson, Bingham assumes a motor theory for both rhythm and melody:

The experimental study of rhythm has, however, disclosed a motor phenomenon essentially like the large, basic motor activity underlying a melodic unity.<sup>25</sup>

Krueger can also be classed in this group:

The affectively toned auditory experiences, especially the rhythmical, never appear without the characteristic sensory components of motor origin.<sup>26</sup>

There are several systematic writers who have given the kin-

<sup>21</sup> Miner, J. B. Motor, visual, and applied rhythms, *Monog. Suppl., Psychol. Rev.*, 5, 1903, 17.

<sup>22</sup> Stetson, R. H. Rhythm and rhyme, *Monog. Suppl., Psychol. Rev.*, 4, 1903, 453ff.

<sup>23</sup> Koffka, K. Experimental-Untersuchungen zur Lehre vom Rhythmus, *Zeits. f. Psychol.*, 52, 1909, 104.

<sup>24</sup> Bingham, W. V. D. Studies in melody, *Monog. Suppl., Psychol. Rev.*, 12, 1910, 83.

<sup>25</sup> Krueger, F. Mitbewegungen beim Singen, Sprechen, u. Hören, Leipzig, 1910, 22.

aesthetic theory place in textbooks of psychology. Among these Titchener may be mentioned:

The author was formerly disposed to attribute a separate rhythmical perception to hearing, but recent observation has convinced him of the existence of kinaesthetic sensations due to the contraction of the *tensor tympani* of the middle ear. . . . In the author's opinion, this [visual] rhythm is always kinaesthetic, based upon eye-movement, upon slight movements which tick off the successive impressions, or upon some other form of intermittent kinaesthesia.<sup>26</sup>

Wallin, one of the most recent investigators in this field, says:

Practically all the subjects made use of kinaesthetic factors—movements of the body, or tongue, or head, or finger.<sup>27</sup>

And Swindle, who gives us the latest study, remarks:

In the development of a rhythm, the motor activity of the skeletal muscles plays the most important rôle.<sup>28</sup>

There is evidence enough, then, that most of the investigators in the field of rhythm conclude that kinaesthesia of one sort or another plays the most prominent part in rhythmical perception and in its development. This is the factual side of the case: with possibly only a few exceptions, all the statements made are the result of observations under controlled conditions.

*B. Theoretical.*—A large literature has recently made its appearance in connection with discussions concerning the fundamental principles of psychology. With it has come the slogan of 'the science of human behavior.' This plea for the study of behavior brings with it, on the theoretical side, a heavy stress on the motor responses of the organism. Statements like the following, selected at random from the works of expositors of this type of psychology, illustrate the tendency toward a renewed emphasis on kinaesthesia:

The science is being developed on the one hand by zoölogists and on the other hand by comparative psychologists. These scientists are studying those visible movements of the animal organism which constitute the external physiological processes.<sup>29</sup>

We may express the relation which actually obtains between them by saying that physiology investigates the processes of the parts or organs of which any organism is composed, while psychology investi-

<sup>26</sup> Titchener, E. B. A text-book of psychology, New York, 1910, 345.

<sup>27</sup> Wallin, J. E. W. Experimental studies of rhythm and time, *Psychol. Rev.*, 19, 1912, 295.

<sup>28</sup> Swindle, P. F. On the inheritance of rhythm, this *Journal*, 24, 1913, 202.

<sup>29</sup> Parmelee, M. The science of human behavior, New York, 1913, 1.



gates the activities of the organism as a whole, that is those in which it operates as a whole or unit.<sup>30</sup>

If psychology is to be defined as the science of human behavior, the term 'behavior' must be used in the widest sense. It must include everything from the simplest movements of walking or of fingering the pen to the activities involved in swaying an audience by speech or in carrying to completion some great engineering work.<sup>31</sup>

A complete explanation of any phase of consciousness can be neither in terms of sensation nor in terms of movement exclusively, but must include both.<sup>32</sup>

The scheme of habit which James long ago described—where each return or afferent current releases the next appropriate motor discharge—is as true for 'thought-processes' as for overt muscular acts.<sup>33</sup>

The psychology which I should attempt to build up would take as a starting point, first, the observable fact that organisms, man and animal alike, do adjust themselves to their environment by means of hereditary and habit equipments. These adjustments may be very adequate or they may be so inadequate that the organism barely maintains its existence; secondly that certain stimuli lead the organisms to make the responses.<sup>34</sup>

In theory at least, if not in substance, all of these references hark back to the well-known and oft-quoted passage from Ribot:

It is always necessary to recall that fundamental principle: every mental state is accompanied by manifestations which are physically determined. Thought is not—although many, influenced by tradition, would admit it to be—an event that has passed into a suprasensible, ethereal and incomprehensible world. We repeat with Setchenoff, 'no thought without expression,' *i.e.*, thought is a word or an act in a nascent state, that is to say, the beginning of a muscular activity.<sup>35</sup>

But already has this movement to emphasise the motor response as an interpretable datum of psychology found antagonists. Thorndike assails the 'ideo-motor' theory in part with these words:

The theory of ideo-motor action has been for a generation one of the stock 'laws' of orthodox psychology. It is taught as almost axiomatic in standard treatises—is made the explanatory principle for phenomena of suggestion, hypnotism, obsessions and the like—and is used as the basis for recommended practices in education, psychiatry, religion—even in salesmanship and advertising. . . .

<sup>30</sup> McDougall, W. *Psychology, the study of behavior*, New York and London, 1912, 35.

<sup>31</sup> Pillsbury, W. B. *The essentials of psychology*, New York, 1911, 2-3.

<sup>32</sup> Pillsbury, W. B. *The place of movement in consciousness*, *Psychol. Rev.*, 18, 1911, 99.

<sup>33</sup> Watson, J. B. *Psychology and behavior*, *Psychol. Rev.*, 20, 1913, 174 (note).

<sup>34</sup> *Ibid.*, 167.

<sup>35</sup> Ribot, *Psychologie de l'attention*, Paris, 1889, 20.

The connection whereby likeness or representative quality, in and of itself, created a bond between a thought and an act, would be 'mysterious' if it existed. But it does not exist.<sup>36</sup>

If the motor response is to be taken *ipso facto* as a criterion to which we are to refer the contents of consciousness, with the additional strong subsumption that it is the only criterion, then it appears that the elaborative functions of the cortex are summarily ruled out of court.<sup>37</sup> That under varying conditions we consciously ascribe divers meanings and references to our kinaesthetic complexes, and that kinaesthesia, aside from other contents of consciousness, is only a part of the material which the cortex elaborates, is apparently overlooked. As to the direct interpretation of 'movement-curves' as graphic or even symbolic representations of conscious processes, it seems only necessary to indicate that there is a manifest confusion of the categories of at least two sciences, psychology and physics. Even casual introspection of our everyday experiences shows that an extensive or an intensive motor response may count for very little in consciousness at one time, while an imperceptible movement or a kinaesthetic image may mean much at another. Psychological meaning is not a matter of extent or intensity of movement, but of extent of elaboration.<sup>38</sup> The spatial and temporal attributes of the physical universe cannot be taken over bodily into the psychological.

A psychophysical interpretation of the rhythmical consciousness can also be criticised from approximately the same angle. The assumption of an equivalence between the psychical and the physical is an error into which the investigator is apt to fall if he insists upon too rigid an interpretation of psychophysical data, or if he handles those data as if they exhausted the contents of consciousness under examination. Quantitative psychology must be made coördinate with qualita-

<sup>36</sup> Thorndike, E. L. Ideo-motor action, *Psychol. Rev.*, 20, 1913, 91-106.

<sup>37</sup> V. Titchener, E. B. Psychology of feeling and attention, New York, 1908, 309; also Bentley, M., this *Journal*, 17, 1906, 293f.

<sup>38</sup> Ebbinghaus, H. Grundzüge d. Psychologie, Leipzig, 1908, II § 70. Höfding, H. Outlines of psychology, Leipzig, 1893, 114.

James W. Principles of psychology, New York, 1890, II, 3.

Ladd, G. T. Psychology, descriptive and explanatory, New York, 1894, 661.

Thorndike, E. L. Elements of psychology, New York, 1905, 65.

Titchener, E. B. A text-book of psychology, New York, 1910, 367.

tive psychology; neither is sufficient without the other.<sup>39</sup> So, while we cordially welcome psychophysical experimentation in this special field when its results are duly qualified in the manner indicated, we do not think that Woodrow's characterisation of the method of procedure and of the problem is at all comprehensive:

The typical procedure in the investigation of these rhythmical factors has been to present a series of sounds or other stimuli, some of which are longer, more intense, or of different quality than the others, and to ask the observer to describe his impression of the series, especially as regards the way in which the stimuli appear to be grouped. Such a procedure is characteristically a psychophysical one, just as much as when two weights are presented to an observer for him to lift, and then to describe his impression of them with special reference to their relative heaviness. In both cases the investigation is one of the relationship between certain conditions existing in the environment and the nature of the subject's consciousness under the existing conditions.<sup>40</sup>

All this is but part of the problem. Not only must we investigate the "relationship between certain conditions . . . . and the nature of the subject's consciousness," but, in order to establish the relationship between conditions that are known, *i. e.*, the physical conditions of the experiment, and the "nature of the subject's consciousness" which is unknown, we must investigate the nature of that consciousness. The history of the reaction experiment tells the same story: after decades of psychophysics, it was left for Ach to publish in 1905 his book *Ueber die Willenstätigkeit und das Denken*, in which for the first time a systematic psychology of volition and action, based upon introspective data from the reaction experiment, is presented.<sup>41</sup>

Although several investigators have contributed introspective material in the field of rhythm, there is still a dearth of analytical observations systematically controlled and obtained from trained and practised subjects. So the statement which Meumann made in 1894 still holds, in a measure, to-day:

What we still lack, more than anything else, is a comprehensive description of the psychical phenomena of the inner life, which we call rhythmical, and a reference of these phenomena to the action of general psychical factors, as well as the investigation of the conditions which make rhythm possible.<sup>42</sup>

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<sup>39</sup> Cf. Titchener, E. B. *Experimental psychology*, New York, 1905, vol. II, pt. I, xxxviii.

<sup>40</sup> Woodrow, H. The rôle of pitch in rhythm, *Psychol. Rev.*, 18, 1911, 54.

<sup>41</sup> V. Titchener, E. B. *This Journal*, 21, 1910, 416.

<sup>42</sup> *Op. cit.*, 273.

## II. EXPERIMENTAL PROCEDURE.

It was partly in view of the fact that introspective material of an analytical sort is comparatively scarce, partly because we believed that in previous investigations not enough emphasis had been laid on that aspect of kinaesthesia which gave it *meaning* or *reference*, and partly on account of theoretical considerations in regard to the importance of contributing factual data which might help to strengthen or weaken current views centering about the motor responses of organisms, that this investigation was undertaken. The nature of the rhythmical consciousness had not been sufficiently analysed from the introspective side to warrant generalisation about its contents.

*A. Problem.*—The task before us was to produce by physical means a series of impressions which would, under ordinary conditions, group themselves together in a rhythmical relation; to secure as faithful a description of consciousness, under these conditions, as practice and training on the side of the observers would permit; and to use as effective means of control and check on conscious contents as methodological approach and systematic observation on the side of the experimenter would allow. Further analysed, our problem involved a variation of conditions in order to present rhythms of different kinds under objective control, and a variation of instructions for the purpose of bringing different types of consciousnesses under subjective control. Some of these instructions focused attention on the kinaesthetic complexes present, but these instructions were given only after there was definite evidence of actual kinaesthesia.

*B. Observers.*—The observers in this experiment were either members of the Department of Psychology or graduate students of one or more years' standing. They were: Dr. Geissler (Ge), instructor, Mr. Foster (F), research assistant, Mr. Boring (B), assistant in the department; Miss Burr (Bu), Miss Day (D), Mr. Edwards (E), and Miss Goudge (G), all graduate students in psychology. In a few observations Dr. Bentley (Be), assistant professor, and the writer (R), instructor in the department, also took part. None of the observers reported in all of the experiments; D and G served, however, in about three-fourths of the total number. Arranged in descending order, according to the amount of introspective training and practice, the observers may be classed as follows: Be; Ge; F; D; B, E, G, and R; Bu.

In order to ascertain the degree of musical training which the observers had, as well as to determine the approximate nature of their experiences in every-day life when they were listening to musical renditions, those observers who took part in the more important experiments were requested to answer the following confidential questionnaire:

1. Have you had any courses in any branch of music in high school or in college? If so, outline them.
2. Have you had any training in singing outside of school and college courses? If so, to what extent?
3. Do you play any musical instrument? If so, with what degree of proficiency? For how many years have you played?
4. Can you tell the approximate absolute pitch of any given note?
5. Can you analyse any given chord into its constituent parts? Can you name the given chord?
6. Do you consider yourself possessed of a good 'musical ear'?
7. To what extent, concisely stated, do you appreciate music?
8. Psychologically considered, how does music generally affect you—what phenomena does it arouse?
9. Do you carry melodies auditorily? If not, how do you carry them?
10. To what extent do melodies play a part in your every-day consciousness?

(After you have answered the above, uncover and answer question No. 11 below this slip.)

11. UNDER THIS INSTRUCTION RECALL A CONCERT OR RECITAL WHICH YOU HAVE RECENTLY ATTENDED: What have you now in consciousness?

Although most of the observers stated that they would be willing to have the answers to these questions published, the writer considered it fairer to treat the information obtained as confidential. While, therefore, the records of the questionnaire are available in the protocol, we must rest content with generalisations based upon the answers received without making their application personal. Almost all of the observers had had practice in playing some musical instrument with some degree of proficiency; over one-half of the number had received instruction in piano-playing, organ-playing, violin-playing, or singing, covering periods from about one year to five years or more in duration. A few had learned the rules of writing harmony and melody; one observer possessed the sense of absolute pitch. Almost all could analyse a given chord under attention; but very few could name its constituent parts. All appreciated good music in a fairly high degree; the writer believes that there is sufficient evidence for the statement that in all cases the aesthetic judgment was well developed in the field of music, and that there was real musical enjoyment. Most of the observers hum, whistle, or sing melodies to themselves, ordinarily, although they may at times imagine melodies in terms of auditory-kinaesthetic complexes. For some of them, organic and visceral sensations play a large part in the appreciation and recall of musical experiences. In these cases the rhythm may be conveyed "in indefinite kinaesthesia." Another found "muscular sensations in body, neck, and head which come from an involuntary attempt to keep time and to use bodily movement to help me do so." Under the instruction to recall a concert or recital, and to report upon the consciousness thus aroused, almost all of the observers got

associative visual, kinaesthetic, auditory, and auditory-kinaesthetic imagery. "Then auditory-verbal images, 'Evening Star,' and auditory imagery of certain parts of the selection, *especially* of the loud clarinet tones, strain sensations in throat, and kinaesthetic imagery in arms (playing piano) with vague auditory images of piano notes accompanying clarinet. Visual images of clarinet player and his chair, localised in part of the room." "Auditory images and kinaesthetic images in throat (of the notes) and kinaesthetic sensations in right foot and ankle (the latter meaning 'keeping time,' and also 'an aid to recall')." "Also vague auditory imagery of high-pitched notes for the 'swings.' Then verbal idea: 'and symphony—Beethoven.' Vague visual imagery of Boston Symphony Hall." "The present memory of this song is a visual image of Bispham on the stage, open mouth very clear, with two very clear successive throat-feels, meaning a high and a low note respectively. An auditory component accompanies the upper note but the lower one is entirely kinaesthetic." "My memory consists of vague visual images of the players and strong kinaesthetic images of bodily position."

The value of these answers as introspective material for our experiment is, of course, very doubtful. The material was, for one thing, not obtained under experimental conditions of control; for another, it has all the shortcomings of a questionnaire method of attack. It did, however, orientate the writer in regard to his observers, and gave him an estimation of their value in a series of experiments of this nature.

At one time in the series, when the investigation concerned itself with rhythms whose constituent members differed physically in pitch, it became advisable to test the observers who took part in that particular problem in regard to their ability to discriminate pitch. The *DL* was accordingly determined for D, E, and G, by the *method of limits*. Two Spindler and Hoyer forks pitched at *a'* (435 vd.), with attached automatic hammers, were used,<sup>43</sup> and 40 series, in addition to the usual number of preliminary series, were taken. The results gave: *DL* for D = .4 vd., for E = 1.82 vd., and for G = 1.86 vd. These results average below the mode obtained by Mount and Smith in investigations with 781 undergraduate men and women.<sup>44</sup> Their results taken from crude tests with steps of one or more vd. show the greatest percentage of frequency at 2 vd. (21 + %) for *a'* of 435 vd. Our steps were uniformly equal to .65 vd. In comparison with what has been found in psychophysical experiments of this sort, our results are a trifle high, indicating relatively poor pitch discrimination (with the possible exception of D). Luft, by the same method used on himself, found a *j.n.d.* of .251 vd. at *c''* and one of .232 vd. at *c'*, the octave which includes our own determinations.<sup>45</sup> Titchener says: "The value of the *DL* (absolute) as obtained under the described conditions has never exceeded 2 vs. for either set of forks, and has fallen as low as .75 v."<sup>46</sup> While, therefore, in terms of Luft's results our observers were on the whole poorer in pitch discrimina-

<sup>43</sup> These are listed in catalog no. 21 as no. 130b, but riders and automatic hammers are not listed as attached.

<sup>44</sup> V. Seashore, C. E. The measurement of pitch discrimination, *Psychol. Rev., Monog. Suppl.*, 13, 1910, 43.

<sup>45</sup> Luft, E. *Philos. Stud.*, 4, 1888, 511.

<sup>46</sup> Titchener, E. B. *Experimental psychology*, New York, 1905, vol. II, pt. II, 126.

tion, nevertheless, in terms of Titchener's statement, one of our observers, D, was below the .75 v. mentioned, *i.e.*, better, and the other two were not unfavorably comparable with the worst.

*C. Apparatus.*—It is almost inevitable, at the present stage of investigation, that the arrangement of apparatus for the adequate control of experiments in acoustics, and especially in the field of auditory rhythm, should be complicated. Parts of the apparatus must be constantly modified to suit new conditions, other parts must be invented for the same purpose. In the early preliminary experiments an ordinary Mäelzel metronome was used. It was, however, carefully selected with a view to eliminate any qualitative differences in the beats. The settings used gave: 42, 48, 66, 92, 152, 176, and 200 beats to the minute.

The metronome was placed on a heavy piece of harness-felt and covered over on all sides, except on the side toward the observer, with an inner lining of cotton batting and an outer layer of harness-felt, held in place by a caging built up of wire supports. This cage measured in all about 70 cm. in diameter and 40 cm. high. It prevented the possibility of echoes from the walls of the room, while it at the same time permitted the sound of the metronome to be heard clearly by the observer, who sat with his back toward the opening of the cage, 2 m. away. This arrangement, of course, also eliminated to a great extent the clang elements present in the ordinary metallic click. Rubber pads on the chairs in the room and felt pads on the feet of the table used for the metronome made occasional movements of these pieces of furniture practically noiseless. A contrivance for starting and stopping the metronome when the experimenter was at a distance away from the instrument was used. This consisted essentially of a wire bar padded with felt and fastened on one end directly to the side of the cage at its front opening and, on the other end, by means of a rubber band to the opposite side of the cage. At the latter end a piece of string was attached which the experimenter held in his hand. The pendulum of the metronome was then placed at one of its extreme positions against this horizontal bar. When the string was pulled, the pendulum was released; when the string was released, against the pull of the elastic rubber band, the bar sprang back in place and caught the pendulum. With a little practice the experimenter was able to catch the pendulum at one of its extreme positions, so that the next pull of the string would find the pendulum ready to begin an excursion. A contrivance of this sort was found necessary because of the advisability of having the experimenter near the observer, while the latter was observing the rhythm produced, in order to detect, if possible, any movement of exposed parts of the body, or any change in breathing. The crudity of such a method of experimental control of the observer is realised and acknowledged, but the series was of so preliminary a nature that it was not considered necessary to take detailed and accurate means of registration until the problem had been clearly outlined.

In the second part of the preliminary series, where an objective rhythm was produced in terms of differences of in-

tensity of sounds, a Titchener rhythm-box was used in connection with the metronome.<sup>47</sup> But, like the latter instrument, this rhythm-box had also to be modified to meet our requirements.

It became necessary to begin a rhythmical series on an unaccented beat, *i.e.*, with an unintensified member of the group; it was also imperative that a rhythm be started and stopped at will. For this reason a releasing and arresting device was attached to the box. The principle of this was practically the same as that used in connection with the metronome in the first part of the preliminary series. Its operation was entirely noiseless. A full account and an illustration of the attachment has already been published.<sup>48</sup>

The observer sat in the same position in this second series of the preliminary set as in the first, and in all other respects the physical conditions were the same.

In the main series of experiments a complete change of apparatus and of the general experimental conditions was necessary. It was our intention to work as far as possible with pure tones combined to produce a two-membered group. These tones were to be variable within certain limits in pitch, intensity, and duration. Two adjacent rooms in the center of the upper floor of the laboratory, and therefore comparatively free from disturbing noises, were used for the rest of the experimental series. One of these rooms, an inside dark-room, in which the observer sat, was separated from the other, in which the experimenter and the greater part of the apparatus were placed, by a heavy stone wall 50 cm. thick. Since the variability of the tones produced, in regard to pitch, intensity, and duration, was the factor that separated the entire main series of experiments into smaller divisions, it will be well to designate these divisions in some arbitrary manner. If we call the two large divisions of the preliminary series, the one concerned with subject rhythmisation, the other with objective rhythmisation, respectively *A1* and *A2*, then we may call the divisions in the main series, *viz.*, one concerned with objective differences of duration, another with differences of intensity, and the third with differences of pitch, respectively *B1*, *B2*, and *B3*.

In the experiments *B1*, two tones were produced, whose relative duration was variable. In all cases the intervals between the tones were constant: one short interval, and one long interval of approximately twice its length, followed one another in alternation, *e. g.*, tone (variable duration)—short interval—

<sup>47</sup> Listed in Stoelting's catalog, Dec., 1909, as no. 7414.

<sup>48</sup> Bentley, M., Boring, E. G., and Ruckmich, C. A. New apparatus for acoustical experiments, this *Journal*, 23, 1912, 513.



tone (variable duration)—long interval—cycle repeated, *etc.* The intervals were kept uniformly constant in duration throughout all of the series *B*<sub>1</sub>, *B*<sub>2</sub>, and *B*<sub>3</sub>. It must also be understood that whenever mention is made of the variability of one of the factors of the tones, *i. e.*, pitch, intensity, or duration, the other factors, not spoken of as variable, are constant. A tone, for instance, which is variable in duration, is not variable in pitch or intensity.

For meeting the conditions of the *B*<sub>1</sub>-set of experiments, a fork of Koenig manufacture and belonging to the Helmholtz set<sup>49</sup> for synthetically reproducing vowel sounds, was enclosed in a sound-proof box. The fork of 256 vd. was used with its cylindrical resonator because it produced the clearest and best-carrying tone of the set. Connected electrically in series with it, but, of course, outside of the sound-proof box, the exciting-fork, from the same set, was utilised for the purpose of keeping the *c'*-fork in vibration. Opposite the opening of the resonator of the *c'*-fork, a telephone transmitter of especial construction was placed.

The transmitters and receiver used in these experiments were made with a view to the most faithful, but not the most intense, reproduction of sound and had been chosen at the recommendation of a member of the Department of Physics. The type of transmitter was no. 227W and that of the receiver was no. 128W, both made by the Western Electric Co., of New York City. That the sound produced by this telephonic circuit was normally tonal in character is shown by the following quotations selected from the reports of the observers when the apparatus was working under standard conditions: (D) "Noticed tonal difference and began saying 're, ti,' 're, ti,' *etc.*" At another place D refers to the sounds as being 'musical' and 'bell-like.' (E) "Auditory sensations from first stimulus, perceived as tone; but I am unable to perceive the rhythm." "Tones seemed to hold the center of consciousness this time." "Tones were immediately reproduced auditorily—it seemed as though I could hear my own voice singing them." G remarks: "Now feeling of doubt became clearer especially in the period between the groups of tones—at other times general trunk kinaesthesia would be clearer—always clearer when tone was pleasant." "At these times, auditory sensations of tone, a kinaesthetic swing of the trunk with each auditory sensation." B: "Auditory perception of first tone, accompanied by kinaesthetic strains in chest." "Then auditory perception of second tone interrupted it. I do not know what happened to kinaesthesia then (as I think I was surprised at quickness with which second tone appeared)." F: "Attention went from the tones to visual image of paper on which I was to write." "Now attention goes back to louder, lower, tone (*i. e.*, after judging) and it immediately became first tone of a foot, I had lost one tone." In addition to these statements, it may be said that the observers generally had no

<sup>49</sup> For a description of this apparatus *v.* Helmholtz, H. The sensations of tone, (trans. Ellis), 2nd ed., London, 1885, 119-23.

trouble in assigning a pitch to the sounds produced. That the tones produced were wholly free from clang-quality can not be asserted. When the entire apparatus was working at its best, however, a tone with only a few clang elements resulted.

The telephonic circuit which embraced the transmitter passed out of the sound-proof box through a suitable induction-coil and storage battery. From the secondary of the induction-coil, it was led to an interrupting apparatus of special design.

Various types of interrupting devices were tried out only to be discarded. The Meumann time-sense disc, geared to the Ludwig-Baltzar kymograph, was tried in connection with small interrupting magnets for making and breaking circuits relayed from the time-sense disc, but difficulties arose in regard to the improper response of the magnets owing to hysteresis. Later an Edison phonograph with an electric motor whose speed was kept constant by means of a ball-governor was substituted.<sup>50</sup> The governor automatically shunted the current through a resistance-coil when the speed tended to increase. On the cylinder of the phonograph a wax-record was mounted. The record was covered in the following manner: over a little less than one-half of its circumference and extending the whole length, a strip of smooth white paper was pasted; the remainder of the surface was covered with two strips of triangular shaped tin-foil, separated by an oblique section of white paper whose width was equal to one-half of the wider strip of white paper. The triangles were equal right-angle triangles and their hypotenuses were adjacent to the oblique strip of white paper; they were inverted and apposed so that the point formed by the union of the longer arm and hypotenuse of one was in circumferential line with the shorter arm of the other, and *vice versa*. In place of the ordinary style and diaphragm, a contact-arm ending in two platinum-wire fingers was substituted. These wires were connected through switches to the secondary circuit of the telephonic system, so that whenever the two fingers passed over a section of the tin-foil the circuit was completed. As the record was rotated, then, these fingers would pass, for instance, at the extreme left of the record, over the circumferential width of a strip of tin-foil nearest the tip of the first triangle, making a very short contact, then over the width of the oblique section of white paper, making no contact and, therefore, the interval between the two members of the group, then over the width of the second strip of tin-foil, this time nearest the shorter arm, and, therefore, comparatively a long contact, and finally over the widest strip of paper, giving the long interval between the groups: in all producing an iambic rhythm. By shifting the arm along the length of the record, gradual changes, from iambic at the left, through spondee in the center, to trochaic at the right, could be effected. The amount of these changes was read off from a millimeter scale on the record. It is understood, of course, that the intervals, both within and without the group, remained constant. The times of these component factors of the rhythm-group were: first member, variable from 0" to .6", the interval between members constant at .5", the second member, variable from .6" to 0", the long interval

<sup>50</sup> A sketch of this type of phonograph can be found in the Standard Dictionary, edition of 1908, under 'phonograph,' pg. 1329.

between groups, constant at .9"; in all, the time for a complete cycle was 2.0".

This method of interrupting the circuit had to give way to another, because the contacts between the platinum points and the tin-foil were not of the best. Almost invariably a scraping noise could be heard in the receiver. To eliminate this, a rotating cam-device for interrupting the circuit was resorted to. The phonograph-motor was still used, but its cylinder-drum was used as a driving pulley with a belt-gripping attachment. The belt passed over the pulley of the rotating cam-device and allowed triggers to drop alternately into small mercury cups. A complete description of the mechanism and use of this apparatus has already been published.<sup>51</sup> It has since been slightly modified with respect to the operation of the triggers. They are now made to drop more quickly and more deeply into the mercury cups, which are placed side by side, in that their power-arms are comparatively longer than before; since they are now made of heavy piano-wire, and the contact points are therefore sharper and thinner, better contact is made. With this device the time values as shown on kymographic records, a 50 vd. fork writing the time-line, were as follows: first member, variable from 0" to .44", the interval between members approximately constant at .45", the second member, variable from .5" to 0", and the interval between groups approximately constant at 1.0"; in all, the time for a complete cycle was approximately 1.8". Kymographic records were also taken in the same way for the purpose of controlling the speed of the electric motor at various points on the scale of the sliding rheostat. The speed of the motor was regulated to keep the time of the cycle of the rhythm between 1.8" and 2.0" throughout all of the series.

The secondary circuit of the telephonic connection passed from this interrupting device, through suitable switches and through a tube in the wall, to the dark-room where it ended in a receiver of the type mentioned. A head-band was attached to the receiver. The observer wore this receiver continuously throughout a single experiment over the better ear, if there was any choice. It fitted very comfortably and its presence was usually hardly noticed.

The system of signals was arranged so that a light-flash from a 4 c.p. incandescent electric light prepared the observer for the rhythm.

It was agreed that the light should remain on during the period immediately preceding the experiment. When the experimenter was ready to begin, this light was turned off. When the observer was ready, he pressed a button which rang a muffled bell in the experimenter's room. After three seconds from this signal, the switches which started the rhythm were thrown. A double-arm, double-throw switch connected at a single movement both primary and secondary circuits. This was done to insure against leakage from one circuit to the other. It was necessary to keep the wires which carried the alternating current for the signal-light well out of the way of the telephonic circuit, because it was found that the receiver circuit would detect with the greatest delicacy any electric variations within

<sup>51</sup> Bentley, M., Boring, E. G., and Ruckmich, C. A. *op. cit.*, 511-13.

a meter if the systems ran parallel for more than about 30 cm. The observer's eyes were protected from the light by a screen.

The experimenter's room was connected with the observer's room by a speaking tube through which special instructions were given and introspections reported. A stop-cock disconnected this tube while the rhythm was being produced, in fact, through the whole period of observation.

For the *B2*-set of experiments, where the members of the rhythm-group were changed in regard to intensity, only slight alterations in the apparatus were necessary. A second fork, manufactured by Max Kohl, of the same vibration-rate and of the same tonal quality as the first was enclosed in another sound-proof box. Opposite to its resonance-box a transmitter, of the same type as the first, was placed. The telephonic system mentioned above was duplicated so far as its primary circuit was concerned. In one of the primary circuits, however, a 111 ohm resistance-box was inserted.<sup>52</sup> By pulling various plugs, resistances from .1 ohm upwards could be introduced. In this series of experiments, the primary circuits were led to the interrupting device.

New cams had to be made to suit the new conditions. Instead of two shifting cams operating on the same trigger, two cams were made with the same contour, *i.e.*, they were in every respect, save in position on the spindle, identical. In mounting them on the spindle, they were separated about one centimeter and arranged so that their depressions gave a spondee rhythm of the same kind as the other cams had produced in terms of duration when they were operating together, *i.e.*, each cam produced a single rhythmical member whose duration was equal to the duration of one of the members of the rhythms produced in series *B1* when the cams were set at the spondee adjustment; but since they were tripping levers which dipped into separate cups of mercury corresponding to the two circuits of the primary telephonic circuit, both cams together produced a rhythmical group which was spondee in terms of duration, as in series *B1*, but was variable in terms of intensity, depending upon the adjustment of the strength of the current relatively in these two circuits. When the resistance or, what amounts to the same thing, the current was equal in both circuits, the result was a spondee rhythm,<sup>53</sup> when the intensity of the current corresponding to the first connection made was greater than that of the other, a trochaic rhythm would be produced; and when the intensity of the current corresponding to the last contact made was greater than that of the first, an iambic rhythm resulted. In these experiments, the secondary circuit passed directly from the induction coils of the telephonic system to the receiver in the adjoining room without, of course, entering the interrupting mechanism.

<sup>52</sup> This type is listed in the Physical and Chemical Catalog No. 23, March, 1912, issued by the C. H. Stoelting Co., on page 140 as No. 2939.

<sup>53</sup> The point of subjective equality was determined by a long series of judgments given by all of the observers concerned.

It is evident, then, that in this series, a change of intensity in the two members could be effected by throwing resistances into the primary circuits, without thereby changing the constancy of the durational component.

In the *B*<sub>3</sub>-set of experiments, no change was made in the interrupting device. Since the series occasioned variations in pitch between the two members of the group, while the durational and intensive factors remained constant, the forks hitherto used had to be replaced by two forks of identical construction, mounted with riders, and giving a range of about 76 vd., from 228 vd. to 304 vd., a major third (a $\sharp$ -d' $\sharp$ ).<sup>54</sup> They were electrically self-exciting, but the noise of this excitation was not audible through the telephonic receiver, mainly, perhaps, because the transmitter was mounted opposite the resonator of the fork and therefore not in the immediate vicinity of the slight noise produced by the excitation. The forks were about as free from clang elements as the others had been in the other series. The resistance-box, which had done duty in the variation of intensity in the previous series, was cut out of the circuit, and the cam-device for interrupting the primary circuit of the telephonic system was left unchanged.

The forks were equated for intensity as nearly as possible by making the physical conditions identical. This was practicable in this set of experiments because all the elements were the same. In the previous series, different forks were used, the transmitter had therefore to be in a relatively different position for each fork, and the wiring had to be different. An extended set of judgments on the relative pitch, intensity, and duration of the two forks was, nevertheless, undertaken for the sake of practice on the part of the *O*'s and with a view to correct any possible wrong adjustments. We also had difficulty here, as well as in previous sets, with complications produced by one attribute on the adequate judgment of another. Judgments of intensity would very often be confused with judgments of pitch and *vice versa*: but more of this in another section.<sup>55</sup>

Pneumographic records were also taken in this set of experiments. The Verdin pneumograph was adjusted to *O* for chest expansion, rubber tubing was then led through the wall to a Verdin tambour which, together with a Jaquet clock, recorded on the drum of a Ludwig-Baltzar kymograph during the period of the experiment. Later a Kronecker interrupter was used at the 1/25 sec. setting in place of the Jaquet clock

<sup>54</sup> These forks were of a new type, made to Titchener's specifications by the C. H. Stoelting Co., of Chicago.

<sup>55</sup> Stumpf enters into a discussion of this difficulty in his *Tonpsychologie*, Leipzig, 1883, I, 347.

at  $1/5$  sec. because it was considered desirable to get a more accurate reading.<sup>56</sup>

At first the kymograph was placed in the room with *O*, but we soon found that there was considerable distraction caused by the noise of the kymograph-motor. For this and other reasons it was taken out of the room.

In a short series of experiments, light-flashes were used to produce a rhythm. Let us call this series, *L*. Connections were made from a source of direct electric current at about 100 volt pressure through one of the levers of the interrupting device, and from the same source through a resistance, bringing the pressure down to about 50 volts, then through the other lever of the interrupting device. From this device the wires passed on through suitable switches to the adjoining room where they ended in a Mazda incandescent light of 40 watt consumption. This light was placed in a small box,  $17 \times 17 \times 20$  cm., whose inner surface was lined with white Bristol board in order to reflect as much light as possible. On one side of the box was a circular opening 1 cm. in diameter, which was covered with translucent architect's tracing paper. This box was placed midway between *O* and a white screen a trifle over a meter from *O* so that the light from the opening in the box was reflected from the screen, covering an area about 60 cm. in diameter.<sup>57</sup>

The opening of the box was, of course, toward the screen. The screen was bounded by black cloth, which limited the field of illumination to some extent. A 4 c. p. incandescent light was allowed to diffuse its light from a point two meters behind *O* over the screen in order to produce conditions unfavorable to the formation of after-images. *O* was allowed to regard the screen in the period before the experiment began and in the period of preparation. The rhythm produced was, as were all the rest, two-membered, in which either the first or the second flash was the more intense—and also, owing to the conditions, the more extensive—of the two, or with another arrangement of the wiring, both were of equal intensity (and extensity), i.e., the interrupting device was so arranged that it would deliver a current through the Mazda light of 100 v., then 50 v., etc., or 50 v., then 100 v., etc., or 100 v., then 100 v., etc., or 50 v., then 50 v., etc. The Mazda filament lends itself very well to this sort of flash, because it reaches its maximum illumination or glow very quickly (in about .05 sec.). The receiver was naturally disconnected from the telephonic circuit in this particular series.<sup>58</sup>

<sup>56</sup> This interrupter is of the lamella type and is made by G. Hasler, Bern.

<sup>57</sup> The conditions were approximately those of the experiments in light-rhythm by Koffka, *op. cit.*, 6.

<sup>58</sup> After reading this account of apparatus used in the experiment, the importance of physical instruments in our investigation will doubtless be realised. That at least one recent writer challenges our

*D. Method.*—In these experiments over 700 observations were taken during a period of two years, from February, 1911, to February, 1913. Each one of these observations was a detailed introspective account of consciousness during the period of the presentation of the rhythm. Three hundred and sixty-five of these were in the preliminary series, which covered about one half-year's experimentation; the remainder, 313, much more detailed and analytical in character, extended over the remaining year and a half.

In the preliminary experiments, series *A1* and *A2*, subjectively accented and objectively intensified rhythms were investigated. In the series *A1*, which dealt with subjective rhythms, the first instruction used was:

(a) To assume mentally and physically as relaxed a condition as possible: to give a general introspective account of the rhythmical consciousness, with special reference to the process of grouping of the metronome-beats and any change that may occur in that process.

Under this instruction B dictated 17 introspections, Bu 21, D 20, and Ge 4. With every *O* except D the metronome was allowed to run for 45 sec. and the introspections were taken after that period. After the first trial, D having remarked that the changes in her rhythmical consciousness were so numerous that she could not well remember them, her introspections were taken after a 15 sec. play of the metronome. All of the *O*'s preferred and were allowed to keep their eyes closed during these experiments. Noticing that most of the introspections centered about factors relating to accent, we considered it advisable to focus introspection more closely upon this point. To this end the instruction was changed to the form:

(b) To notice in terms of what psychical factors accent is determined.

Under this instruction B dictated 1 introspection, Bu 15 introspections, D 12, and Ge 8.

In the second set of experiments, *A2*, objectively intensified sounds were presented to *O* in rhythmical groups by means of the metronome and rhythm-box.

Again we followed in the main, as we had done in the *A1*-set, the suggestions in Titchener's *Manual*,<sup>99</sup> but evidently for a different

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right to grant this importance, we may gather from a passage in Verrier's *Old Testament and Semitic Studies*, Chicago, 1908, 177: "It is almost superfluous to point out in this connection, that facts which require instruments for their discernment have no place in the study of rhythm."

<sup>99</sup> Titchener, E. B. *Experimental psychology*, Vol. I, pt. I, 176-7; pt. II, 339-47.

purpose than that outlined in the text. Our aim was not so much to discover what form the group assumed or what value, in terms of intensity, duration, or quality, was assigned to the various members of the group, but to obtain a fairly accurate description of the constitution and pattern of the rhythmical consciousness under the influence of the perception, with different degrees of difficulty, of the objective rhythms described below. Bolton had come to the conclusion that the normal group is the two-group; more difficult is the three-group, or the twice-three-group; and still more difficult is the five-group.<sup>60</sup> The rhythms that we used were: ('— —), (— '—), ('— — —), (— — '—), (— '— —), ('— — — —), ('— '— — —), (— — — —), ('— — — — —), ('— '— — — —), ('— '— — — —). Each group occurred twice at three different rates each time (152, 176, 200 per min.). The consecutive order was haphazard, though definitely outlined before the experiment was begun. This means that an easy or difficult rhythm was presented to *O* without his foreknowledge as to the degree of its difficulty. The rhythm usually lasted 15 sec. At the very end of the series, this time was changed for reasons given later.

This *A2*-set of investigations was considered the more important of the two preliminary sets because, in the first place, the *O*'s had gained practice in the introspection of the rhythmical consciousness in the course of the first set; and again, because the experimenter took greater pains to concentrate the instruction on such crucial points of attack as had already been suggested in the course of the *A1*-set and in the early part of the *A2*-set; and finally, because more introspections were taken and a longer period of time was spent on this set.

In these as well as in previous experiments, the usual 'ready' signal was verbally given. The introspections were then taken down word for word and are preserved *in toto* in the protocol. The first instruction was:

(a) To describe the rhythmical consciousness, giving especial attention to (1) the ease with which the particular rhythm is perceived, (2) any change in the rhythm that may occur, (3) the placing of major and minor accents, and (4) the duration of the beats.

Under this instruction Bu dictated 35 introspections, D 24, and Ge 20. Toward the end of the series, it was suggested, especially in the introspections of D and Ge, that there was some change in the nature of consciousness during the period of the playing of the rhythm. This induced us to turn the instruction into the form:

(b) To observe any changes that may occur in the course of the rhythmical consciousness.

Under this instruction Bu dictated 15 introspections, D 16, and Ge 20.

Believing that we could get much better results by resorting to the method of 'fractionation,' well-known in the reaction

<sup>60</sup> Bolton, T. L. *op. cit.*, 212.



experiment, we divided the whole period into two parts, called respectively the 'fore-period' and the 'after-period.'<sup>61</sup> The former began with the objective playing of the rhythm and ended with the clear perception of the rhythm on the part of *O*, at which time the objective rhythm was stopped at a signal from *O*. The latter began with a clear perception of the rhythm and ended with the close of the usual 15 sec. period.

It must be recognised that (1) the dividing point in this fractionation, if arbitrary, was well suited to our investigation because we were hoping to find the critical phenomena which centered about this point, and (2) that it was necessarily indefinite, because the recognition of the rhythm may be gradual and not climacteric, but that with practice this fact presented no unusual difficulty. While a sharp, distinctive fractionation of the period was ideally aimed at, a slight prolongation of the fore-period or the after-period did no serious harm.

Bu gave 9 consecutive introspections under the instruction covering the fore-period, D 15, and Ge 13. The instruction read:

(c) To observe the rhythmical consciousness until the moment when the rhythm is clearly perceived (at which time a signal is to be given to the experimenter to stop the objective rhythm), giving no attention to the report of the kind of rhythm perceived, but making sure that the kind is definitely determined.

Then Bu, D, and Ge each gave ten introspections under the instruction pertaining to the after-period. The objective rhythms previously reported on were repeated for these introspections. The instruction was:

(d) To observe the rhythmical consciousness after the moment when the rhythm is clearly perceived, giving no attention to the report of the kind of rhythm perceived, but making sure that the kind is definitely determined.

Convinced that this method had given enough practice in the recognition of the dividing-point of the entire period, we repeated, in the course of a few weeks following, the rhythms used before, but with instructions *A 2 c* and *A 2 d* arranged in haphazard order.

A direct question was then put to each *O* in the form:

(e) What difference, if any, do you think, is there between the

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<sup>61</sup> For a discussion of the advantages and disadvantages of this method *v.* N. Ach, Ueber d. Willenstätigkeit u. d. Denken, Göttingen, 1905, 19 f., and G. E. Müller, Zur Analyse d. Gedächtnistätigkeit u. d. Vorstellungsverlaufes, Leipzig, 1911, 75 ff.

rhythmical consciousness under instruction *A2c* and the rhythmical consciousness under instruction *A2d*<sup>62</sup>

Finally the rhythmical consciousness was allowed to degenerate, as it were, under instruction *A2d*, by the lengthening of the period from 15 sec. gradually through stages of 20, 25, 30, 35, 40 and 45 seconds duration to the extreme length of 1 min. The *O*'s were not told the purpose of these gradual increases in duration, and were generally and quite surprisingly unaware that the period had been lengthened. D gave 11 introspections, and Ge 7. These experiments ended the preliminary series.

With the commencement of the main series of experiments, there was a complete change of apparatus, and, owing to the beginning of a new academic year, there was also a change of *O*'s. D was the only *O* who continued to serve after the preliminary series. In this part of the main series, which we shall call *BI*, a two-membered rhythm was produced, the difference in whose members was one of duration—other physical factors were constant. Our aim in thus separating these factors was to isolate our conditions as far as possible and to see whether, when we had made these conditions as simple as we could, the facts discovered would be the same or different for each analysis. A 15-sec. period was used, which gave time for about 8 complete rhythmical cycles. Ten different changes in the relative duration of the two members were within the limits of the efficiency of the apparatus, and these were made in haphazard order. The first instruction was:

(a) To give an introspective analysis of the perceptual consciousness.

D gave 15 introspections, E 8, and G 12. Noticing that, in spite of the fact that there were no differences in pitch and intensity between the members as they were physically produced, the *O*'s were frequently reporting such differences, we saw no way of avoiding the giving of full and explicit instructions as to the physical possibilities involved. The next instruction, therefore, was:

(b) The sounds which you will hear will be objectively of the same intensity and pitch but will vary in duration as follows.

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<sup>62</sup> This is a sort of modified 'method of confrontation' as it was used by T. Okabe, in his *An experimental study of belief*, this *Journal*, 21, 1910, 590. For a criticism of the method v. K. Koffka, *Zur Analyse d. Vorstellungen u. ihrer Gesetze*, 1912, 21.

Then in every instance the type of rhythm was announced. This instruction was supplementary to *B1a*. D dictated 7 introspections, E 8, and G 2. But the *O*'s persisted in making the confusion of judgments of intensity, pitch, and duration. A series of judgments was then given with sole regard to the estimation of pitch, intensity, and duration of the second member in terms of the first. Using the settings which corresponded to judgments of equal intensity and equal pitch in each individual case, and with the knowledge on the part of the *O* that this was being done, we repeated instruction *B1a*. This resulted in 5 introspections from D, 5 from E, and 10 from G.

We found, after we had taken this number of introspections, that two of the *O*'s had come to think that the experimental conditions were not what the experimenter said they were, and that he, perhaps, was trying the effect of suggestion on the perception of rhythm. To meet these conditions the following instruction was given:

(c) Throughout the series of rhythmical experiments, suggestion is not resorted to; the knowledge given is in terms of true objective conditions.

Under this instruction D gave 8 introspections, and E 2. After this, we allowed the rhythm presentation to continue for 45 sec. and asked for as detailed an account as was possible under these circumstances. D gave 20 introspective reports, E 6, and G 24.

In order to get at the differences in conscious pattern during the course of the period, we again resorted to the method of 'fractionation,' dividing the total period into three parts as the following instructions will show:

(d) Give a minute analysis of consciousness during the period extending from the 'ready' signal to the first auditory impression; and report upon the pitch, intensity, and duration of the members of the group presented.

(e) Give a minute analysis of consciousness during the period extending from the first auditory impression to the time when the two auditory impressions are perceived as belonging to a group; and report upon the pitch, intensity, and duration of the members of the group presented.

(f) Give a minute analysis of consciousness during the period extending from the time when the two auditory impressions are perceived as belonging to a group to the end of the experiment; and report upon the pitch, intensity, and duration of the members of the group presented.

D gave 10, 7, and 9 introspections under the above instructions, respectively; E gave 4, 4, and 1; and G gave 5, 6,

and 8. A few introspections among these were taken under the last instruction while the period was lengthened gradually to 1 min. Finally, the above instructions were given in haphazard order, to make sure that the *O* was not getting practised to the point of giving a 'habitual report,' *i. e.*, in stereotyped form. D gave 24 of these introspections, and E 9.

In the *B2*-set of experiments, changes were made in the relative intensity of the two members of the rhythm-group, while the other factors remained physically constant. The most frequent settings of the resistance-box which introduced these changes of intensity were 0 ohms, 2.5 ohms, 3 ohms, 4 ohms, 10 ohms, and 20 ohms. At first all the *O*'s were called upon to give a series of judgments on the relative duration, pitch, and intensity of the two members. Then a general instruction was given:

(a) Give a detailed introspective account of the perceptual consciousness and report upon the relative intensity of the two members.

D gave 2 introspections, E 4, and G 14. D was then asked to 'fractionate' her reports as in *B1d*, *e*, and *f*. She gave 7 introspections under this instruction. G gave 3 on the first period only. D was also asked:

(g) To introspect consciousness during perception with as passive an attitude as possible.

She gave 8 introspections as the result of the instruction. A series of additional judgments was then taken on account of a slight improvement in the apparatus. Finally D and E were asked:

(h) To give an introspective account of consciousness; and to report upon the relative pitch, duration, and intensity of the two members.

Under this instruction, the period was made as long as 1 min. D and E gave 3 introspections apiece.

In the third set of experiments (*B3*), changes in pitch were effected, while the other components remained constant. The changes were again made in haphazard order and ranged from *a♯-d'♯*. At first a long series of judgments was taken in order to secure practice in the discrimination of the relative pitch of the two sounds. Then the method of 'fractionation' was at once resorted to, and since the instructions were similar to those of *B2d*, *e*, and *f*, we shall designate them in the same way, *B3d*, *e*, and *f*. B gave 7, F 5, and G 8 introspections in all. Since this series of experiments

began at the commencement of a new academic year, a change of *O*'s was made necessary. This accounts for the presence of *B* and *F* as *O*'s in this part of the series. Finally instructions *B* 3 *d*, *e*, and *f* were given in haphazard order. *B* gave 8 introspections, *F* 13, and *G* 10.

In order to get at the significance of kinaesthetic factors in the perception of rhythm in a slightly different manner, we aimed to find out what would happen to the perception of rhythm when an instruction was given to suppress these factors. Accordingly the following was given:

(\*) Report upon the course of consciousness while inhibiting kinaesthetic processes which are relevant to the rhythmical grouping of the auditory perceptions.

This was done with a pitch-rhythm as a stimulus. *B* gave 2 reports, *F* 5, and *G* 4.

To discover whether what we had found in regard to auditory rhythms would also hold true of visual rhythms, we tried a short series with light-flashes differing in degree of intensity, and forming a two-membered group on the same pattern as the auditory rhythms. After a series of preliminary judgments with respect to the relative intensity of the two members, the instruction was given:

(a) You will see a series of flashes on the background opposite you, which background you will fixate upon. Report your total consciousness, and judge the relative intensity of the two flashes.

Under this first instruction of this series, which we will call *L*, *B* wrote 2 introspections, *F* 5, and *G* 6. The instruction was then 'fractionated' as before. Under these instructions, which were at first given in order and then in haphazard arrangement, and which we will label *L* *d*, *e*, and *f*, *B* wrote 5 introspections, *F* 7, and *G* 6. It will be remembered that in the description of apparatus we mentioned that pneumographic records were taken in both series, *B* 3 and *L*. In one or two places, supplementary questions were asked where the introspection was not perfectly clear. These questions will be given in connection with the introspective results.

At the end of the entire investigation, another 'confrontation' question was put:

(z) Can you describe, in a general way, the course of kinaesthetic processes during the period of the experiment?

To this question *B*, *D*, *F*, and *G* gave detailed answers.

## III. RESULTS

*A. Preliminary Series.*—Under the first general instruction, *Alia*, we obtained the following typical introspections:

(B) A two-group with decided pauses between the two members. There is a difference between the two members which does not seem to be qualitative, intensive, or durational. I wondered what this was. I discovered very vague kinaesthetic or organic sensations in chest and abdomen. These are different for first member and second member, but it is not clear how. First and second seemed to sound alike but *meant* something different due to these organic sensations. Toward the end, idea of four-group suggested itself. This was followed by hearing of four-group of two pairs. I do not think that the pause between the four-groups was longer than the pause between the pairs of one four-group. At the end of the four-group, however, there were kinaesthetic sensations in trunk meaning, 'this is the end of it.' These sensations were more intense than those accompanying the hearing of the preceding beats.

[Rate: 48 per min.]

(B) First beat, then long pause, then second beat. Anticipated second beat with the idea of the two-group. Two-group followed and continued when second beat came. Long pause between groups. Very little accent, if any, on first beat. Kinaesthetic sensations in head and body, repeated apparently the same in each group. Vague feelings of swaying (leaning forward) to left in time to the two members of the group. When the idea occurred, it came as a visual image of the leaning. Qualitative differences of the beats discovered toward middle of the experiment. I had idea (not verbal), 'will this change the grouping?' Four-group suggested: next pair became attached to the preceding pair, making the four-group. Four-group continued until the end. The pairs of the four-group seemed exactly like the individual two-groups before,—only that the thing that made the four-group was that one pair persisted as image during the sounding of the second pair. The image was very clear,—probably a memory-after-image. This was in terms of auditory images. There were also less clear visual images consisting of two brown dots on a gray background—meaning the two beats. As soon as the group is completed, the whole complex of the four-group vanishes at once. There seems to be no image persisting from the second pair of the four-group.

[Rate: 42 per min.]

(Bu) Four-group with accent on third beat. Class in calisthenics suggested in terms of visual imagery. Time was considered good for this but still a little slow. Watched the exercises go on with kinaesthetic reproduction in arms. Auditory imagery of music. Strong visualisation of girl at piano. I think my foot moved three or four times.

[Rate: 42 per min.]

(Bu) Four-group with accent on three. It kept singing itself (auditory imagery) like a hymn. Later said: 'well done' like a chant. Foot movements corresponding to the four beats. First and third beats were pitched. Finger moved also. I tried to get rid of 'well done' suggestion.

[Rate: 42 per min.]

(D) Two-rhythm with accent on first beat. Kinaesthesia in throat without articulation and occasionally with counting, 'one, two.' Head moved according to rhythm—down for accent, brought back for non-accent. Strain for accented 'one,' relaxation for unaccented

'two.' Breathing in on 'one' and out on 'two.' There were qualitative changes in the experiment. Visualised soft brown spot on one accented beat. For most of the time, visualised a solid figure of steel-gray-bluish color with angles. More of the accented ones were seen and they were larger. For the first two or three beats there was a tendency to localise the sound behind with a corresponding kinaesthetic strain in the neck. First two or three beats were not rhythmically grouped. Comforting and pleasant rhythm. Feeling of relaxation. [Rate: 92 per min.]

(D) 'Tick, tock' said at the beginning for a few beats. No strong sense of rhythm. It was a rhythm of 'sound,' 'silence.' There were strain-sensations during the sound, and relaxation during the silence. Visualised 'sound' as a space of one inch, and 'silence' of four inches from left to right. The edges of these were clean-cut. Sound was seen as a black line, silence as a long gap. Rather interesting. For a while realised that breathing corresponded: inspiration during sound, expiration during silence. Sounds were heard very slowly, with tremendous pause between them. [Rate: 42 per min.]

(Ge) Second beat started a one-two rhythm with accent on 'one.' The rhythm seemed to be more intense than before, accompanied by verbal counting. Gave up counting and watched for the peculiar beat (mentioned above), but counting still interfered with the perception of this peculiar beat. It was lost again, but later found to be recurring every sixth beat. It seems to be higher in pitch, of less volume, less intensive (?). Idea occurred where this could come from. Bell-arrangements [of some metronomes—not the actual case with the one used in the experiment] were suggested; then gave it up. [Rate: 152 per min.]

(Ge) After a few strokes of no rhythm, a 'one-two' rhythm practically without verbal counting and consisting of sounds only. The accent was on 'two.' Then a few groups of 'one-two' rhythm with accent on 'one.' This was reinforced by verbal counting in terms of kinaesthetic-articulatory sensations. Then confusion followed with no rhythm. Then a 'one-two' rhythm with accent on 'two.' Doubtful whether this lasted until the end. Started to be unpleasant, less unpleasant later, and indifferent toward the end. Required vague organic adjustment, preceded by unpleasant organic disturbance which gradually wore off. [Rate: 92 per min.]

As regards some of these introspections, allowance has to be made for the elementary stage of the experiment at the time. In general, however, certain facts already begin to show. Kinaesthesia is prominent; but it may be kinaesthesia of movements of limbs or head, of gross bodily movements, of respiration, of vague organic disturbances in chest and abdomen, or of articulation. Again, in many instances, kinaesthesia may be accompanied or entirely replaced by a series of visual images of movement. Finally, there may occur visual images of a purely symbolic character, in themselves sufficient for carrying the rhythm. Occasionally, and, so far, very rarely indeed, a purely auditory rhythm, without visual or kinaesthetic accompaniments, is reported. In almost every case of reported head, limb, or respiratory movement

made by *O*, *E* was able to verify the report by actual observation of the movement. As far as *E* could not, there was also complete physical relaxation.

Under instruction *Atb*, which was directed to the introspection of 'accent,' we have the following reports:

(B) Kinaesthetic sensation (or image) of slight nod of head on accent. . . . Deep kinaesthetic or organic sensation in head (like a quick pressure) accompanied by a visual image of something in head pressing downward and frontward toward the mouth. (This may be the explanation of the nod I mentioned above.) Perhaps the kinaesthetic and organic sensations are intensified or else changed at the accent; may be only a change in breathing.

[Rate: 92 per min.]

(Bu) Accent is marked by left foot being put down. . . . Kinaesthetic sensation from left foot, down with accent, up with non-accent. Organic sensations in head and trunk of moving in time with the rhythm. These sensations are more intense on the accent and less intense on the non-accent. . . . Accent felt more on the left side of the body. Down movement with the accent.

[Rate: 92 per min.]

(D) With inspiration came the accent. Accent means strain; non-accent, relaxation. *Spannungsgefühl* less pleasant than *Lösungsgefühl*, but both are by no means unpleasant. . . . Feeling of strain that was continuous through the series but strongest on the accented beat. . . . Accented beats seemed louder, . . . sixth beat louder and visually sharper. There was a long pause after the accented beat. [Note: a description of a visual pattern of figures symbolising the beats follows.] . . . Duration of the beats about the same. Intensity very much the same, though intensity is more marked on the accent. . . . Every accented beat is marked by kinaesthetic sensations of strain in chest (breathing inhibited). There is relaxation for the non-accent. Auditory sensations of accent more intense. Localised accented beats higher up (in kinaesthetic terms of eye-movement). Kinaesthetic sensations in throat more intense and sometimes higher in pitch for accent.

[Rate: 152 per min.]

(Ge) Greater clearness for accented sound. Greater intensity and extensity of articulatory-kinaesthetic sensations accompanying counting. I am uncertain whether greater clearness involves greater subjective intensity of sound. . . . I am surer now about difference in clearness: there is a greater clearness and a longer ring, with a higher pitch, like G—GABC.

[Rate: 92 per min.]

(Ge) A 'one-two' rhythm with accent on 'two.' Second sound differed from first in having greater clearness and in having a peculiar qualitative difference at the end. It seems to last longer. A certain determination was set up to attend to accented sound—I can't get away from it. Felt tongue moving quite markedly extensively and intensively on accented 'two,' while 'one' is articulated more easily (by opening of the mouth). The tongue in saying 'two' seems to interrupt the even breath coming out of the back of the mouth. The verbal 'two' was accented partly by the effort of change involved in the articulation of 'two.' These two different factors are not simultaneous, but sometimes accent is carried on by the auditory differences, and sometimes by the motor differences.

[Rate: 92 per min.]



We may summarise these results by pointing out that (1) there is usually strain for the accent; (2) the kinaesthetic sensations are, for the most part, intensified and, without exception, changed in form or complexity. Especially is this true of the sensations of respiration. (3) Where there is visual imagery, this also changes. Introspective facts reported by one or more *O*'s, but not by all, are: greater clearness for accent, higher pitch, changes in duration, in length of pause after accent, greater intensity of sound. Three points are certainly clear: (1) the kinaesthetic complex changes for accent and non-accent, (2) kinaesthesia on the accent is more intensive and is felt as strain or tension, while kinaesthesia on the non-accent is less intensive and is felt as relaxation, and (3) kinaesthesia, prominent as it is, may be temporarily or entirely replaced by visual or auditory complexes.

Passing on from subjective to objective rhythmisation, we obtained the following introspections from the general instruction *A2 a*:

(Bu) Rhythm: 1, 2" [*as given; rate, 152*].<sup>68</sup> Kinaesthesia of moving foot up, with non-accent; down, with accent. Kinaesthetic sensations of head-movement up, with non-accent; down, with accent. Pleasant affection. 2 much longer than 1, and seemed higher in pitch. Heard tune in the rhythm. Came readily and underwent no change.

(Bu) Rhythm: 1", 2, 3' [*given: 1", 2, 3; rate, 200*]. Moved hand up, and then down with accent, in terms of kinaesthetic sensations. Pleasant affection. No change in accent after the first three or four measures—at first it was on 2. First measure undecided.

(D) Rhythm: 1", 2, 3, 4, 5 [*given: 1, 2, 3"; rate 200*]. 1 was as long, approximately, as the sum of the durations of 2, 3, 4, and 5, but I am not sure about this. At first strain for the accented and relaxation for all of the unaccented. Kinaesthesia of nodding of head with the accent. Then, in addition, strain-sensation for the four unaccented (2, 3, 4, 5), relaxation for 1. 1 became shorter then (*staccato*). Counted only once (one measure) to make sure how many there were in it. No tendency to continue afterwards. Not easily gotten; not pleasant but interesting.

(D) Rhythm: 1", 2, 3, 4, 5 [*as given; rate, 152*]. 1 more intense, clearer, and lasted longer. Later, 4 became accented, lasted longer, and became more intense than 2, 3, and 5. Kinaesthesia of counting to get rhythm which was hard to get and not securely held. More difficult to attend to it than to the rhythm in the preceding experiment [which was a 1", 2, 3 rhythm]. Not very pleasant.

(Ge) Rhythm: 1", 2, 3 [*given: 1, 2", 3; rate, 176*]. First few strokes unrhythmical; caught in second measure. Once thought it was 1", 2", 3. Verbal idea, 'perhaps a slip in raising the cover.' Qualitative difference between accented and unaccented. Not merely a difference in intensity. 'Brighter' [mentioned in a previous introspection as a characteristic of the accented beat] now interpreted as

<sup>68</sup> Note: " means major accent; ' means minor accent.

meaning 'higher pitch.' Unaccented more drawn out. Accented stroke sharp and definite—unaccented lost themselves temporally. Pleasant, 'of-course' rhythm.

(Ge) Rhythm: 1, 2" [as given; rate, 176]. Found at once and kept throughout, mostly as an auditory rhythm, except at the beginning where there was slight verbal counting. Attention very strongly on accent which seemed longer, higher pitched, and more intense than the lower, muffled, and briefer unaccented. Slightly pleasant, with 'familiarity tag.'

In quoting these introspections, in order to allow for practice and accommodation under the instruction, we have followed the plan of selecting one introspection of each *O* from about the middle and one from near the close of the series. The fact which the introspections, taken together with the complete set from which they are abstracted, brings out is that objective accent is, as a rule, of longer duration, more intense, higher pitched, and somewhat clearer than the unaccented beat. A numerical count of the instances of actual mention of these points in the reports is plainly deceptive because, while a characteristic may be noticed, yet very often, owing to the recency of a previous mention or to the unimportant nature of the appearance, no specific account will be given. To support our statement of the facts, however, and with the above reservation, the following table is appended:

	No. of times accented beat reported			
	Longer	More intensive	Higher	Clearer
Bu.....	16	1	3	0
D.....	15	9	1	2
Ge.....	4	5	7	2

In addition to these reported differences between accented and unaccented members, there were introspections on the kinaesthetic, visual, and auditory complexes mentioned in the first series, under the influence of subjective rhythmisation. They did not, however, appear so frequently, nor did they play so prominent a part. This may be due to the fact that the instruction was not focused on this problem.

Our next instruction called for an observation of the changes in the course of consciousness (*A2b*), and gave us results that were especially valuable. During the remainder of the series of experiments, it was this problem, *i. e.*, what are the significant *changes* in consciousness, casually hinted at in the beginning, that occupied a good deal of our attention. The problem is specifically suggested, for example, in such introspections as the following:

(Bu) I counted for the first few measures only. [1, 2, 3, 4 " ; rate, 152].

- (D) Feel that head must be nodded when rhythm is difficult. [*1, 2, 3''*; *rate, 200*].  
 The nodding of the head helped to decide what the rhythm was at the beginning. [*1'', 2*; *rate, 176*].  
 Kinaesthesia of nodding of head, done to fix rhythm. [*1, 2'', 3*; *rate, 200*].
- (Ge) Second and third measures counted; articulation stopped after this. [*1'', 2, 3, 4, 5*; *rate, 176*].  
 Mostly auditory rhythm—there was no necessity for verbal accompaniment except in two doubtful places. [*1, 2''*; *rate, 176*].

In accordance with this instruction (*A2b*), we obtained the following results:

(Bu) Rhythm: *1'', 2, 3', 4* [*given: 1'', 2, 3, 4*; *rate, 200*]. Easily gotten. I did not count after the rhythm was decided. This was done in the first few measures. I thought of jog-trot in time to the rhythm (in terms of kinaesthesia of my own body). Visual imagery of the cadets in double-quick time. Auditory imagery of the band music. All of this occurred toward the end. Pleasant affection.

(Bu) Rhythm: *1'', 2, 3* [*as given; rate, 152*]. When I got it in the second measure, I stopped counting. Auditory imagery of one of the melodies of Easter church songs. Visual imagery, in about the middle of the series, of a minuet-dance. At the very end, kinaesthesia of entering into the minuet. Pleasant affection.

As a rule, Bu has kinaesthesia of nodding of head and of articulatory movements throughout the period, but in two or three reports, she notices, as in the above, that this ceased when the rhythm was certain. In such cases, an irrelevant sort of auditory or visual complex seems to take the place of kinaesthesia. There may be, however, a vague kinaesthesia to accompany this new complex. D is more definite on this point, and, in the large majority of introspections, reports a shading off of the kinaesthetic factor, especially in the capacity in which it occurred at the beginning of the period:

(D) Rhythm: *1, 2''* [*as given; rate, 152*]. . . . Kinaesthesia marked until near the end when the rhythm began to take care of itself. I did not attend to it with so much effort.

(D) Rhythm: *1'', 2* [*given: 1, 2''*; *rate, 176*]. This lasted for about two measures. I was longer and more intensive. Then a *1', 2'', 3, 4* rhythm accompanied by movements of the head—left with first two beats, right with last two. Head really moved for the accent of the first beat. Then there was a plain *1'', 2* rhythm with no kinaesthesia. Rhythm was soothing. I felt drowsy.

(D) Rhythm: *1'', 2, 3 ('?), 4* [*given: 1, 2, 3, 4''*; *rate, 176*]. Rhythm was troublesome at first. Kinaesthesia of jerking of the head to get it, also of counting. Then kinaesthesia dropped out, but I am not positive about this. There was relaxation for the unaccented (last three beats), but this changed to slight feeling of strain, due, perhaps, to slight adjustments of breathing. Affection indifferent. Time seemed to be quickened at the end.

Often a general bodily strain or tension is reported by D as being very prominent at the beginning of the period and as wearing away at the end. The intensity and the pitch of the accented beat, when they are carried kinaesthetically, diminish also. Ge frequently notices that the rhythm becomes merely auditory, with an attitude toward it that is called 'passive:'

(Ge) Rhythm: 1, 2, 3, 4" [*as given; rate, 152*]. Counted once. Not a particularly easy rhythm. At the beginning it was accompanied by kinaesthetic sensations of movements particularly in the back of the mouth and partly in the eye-wink. Then there was a passive attitude of merely listening with the expectation of the accent and with the filling in of the beats. More of a time-rhythm. Time during the expectation period (during the unaccented beats) is felt as strain. Affection somewhat pleasant, straining. The rhythm was caught indifferently.

Occasionally there is also an illusion of an increase in the speed of the rhythm toward the end of the period. This illusion is also reported by D. With Ge it is evident that when a rhythm is simple and not difficult, the auditory nature of the rhythmical perception, and the passivity of attention as mentioned, are characteristic of the entire period:

(Ge) Rhythm: 1", 2", 3, 4 [*as given; rate, 152*]. Very easy and very comfortable rhythm. Passively taken in in auditory terms, except occasional tendency to move parts of the body (especially the right side) in a 1, 2 rhythm—one way with the two accented beats, and the other way with the two unaccented beats. This is an indication of movement, a translation into space perception of that which was not in itself spatial. It seemed to be more of the nature of kinaesthetic ideation of muscular contraction with the two accented, followed by kinaesthetic ideation of relaxation with the two unaccented beats.

As the result of the 'method of fractionation' after long practice and with instructions *A2 c* and *A2 d* arranged in haphazard order, we obtained the following introspections of the first period:

(Bu) Conscious attitude of hesitation during first measure; with the second measure came the verbal idea, 'I must get this.' Then articulatory sensation of counting for two measures. I decided that the second of these was right. Caught it certainly about the fourth measure. Feeling of hesitation and doubt disappeared. Pleasant affection instead. I ceased counting; attitude of satisfaction.

[*Rhythm: 1", 2, 3", 4, 5; rate, 200*].

(D) Auditory sensations of successive sounds of varying intensity, 'Muddled feeling' in terms of organic sensations and 'mixed-up' kinaesthesia. Feeling of strain, chiefly in head. Then out of the muddle of kinaesthesia, I distinguished definite kinaesthesia in throat of definite sequence and intensity. This gave the rhythm. Then 'muddled feeling' went. Affection more pleasant, kinaesthesia less prominent.

[*Rhythm: as given above in Bu.*]

(Ge) Great confusion. Succession of sounds for a long while. Difference in intensity of sounds noticed. Unsuccessful attempts to count, until one accent appeared and was called 'one.' Every time that accent came it was called 'one.' Strong organic background with unpleasant affection, and involuntary inhibition of breathing (this constitutes part of 'confusion'). Breathing resumed after successful counting started. Somehow, but I don't know how, first few strokes seemed to form a visual series (but not of visual images) into which strokes were translated. It was as if kinematic pictures passed too fast to be caught, except their motion. *Bewusstseinslage* of movement present. This may have been due to eye-movement; but eyes were closed. It was more like the trembling of the eye-lids. Localised visual movement in eyes.

[*Rhythm*: 1", 2", 3, 4", 5; *rate*, 176].

### Introspections descriptive of the second period:

(Bu) Kinaesthetic sensation of moving forward with a sort of swaying movement. Left foot put down with accent. Articulatory sensations of counting. Verbal idea meaning, 'I must forget the rhythm and cease counting.' Visual imagery of people marching in parade. Pleasant affection. Auditory imagery of music with tune to suit the rhythm, accentuating with swaying motion.

[*Rhythm*: 1", 2; *rate*, 152].

(D) Mildly pleasant feeling of familiarity dying away after a while. Total relaxation, almost drowsy. Auditory sensations forced themselves on me. Attention passive. Rhythm gradually became unpleasant. Painful sensations in ear-drums becoming more intense toward end. Organic sensations and 'mussed-up' breathing. Rhythm decidedly objective. ['Objective' has been described by D as meaning lack of kinaesthesia that carries the rhythm, and also as meaning that the 'rhythm was definitely localised somewhere outside of me']. Attitude of resentment toward it.

[*Rhythm*: 1", 2; *rate*, 200].

(Ge) Rhythm became clear as soon as verbalised with the accent. It was verbalised, in terms of articulatory sensations of tongue-movements, until the end, but became less intense, easier, and less extensive. Affection changed from unpleasant in fore-period to slightly pleasant in this period. Very concentrated attention on auditory rhythm. This was accompanied or marked by pressure of eye-lids against eye-ball, more particularly at beginning, but as a background to the whole. This was less marked at the end.

[*Rhythm*: 1", 2", 3, 4", 5; *rate*, 200].

In answer to the question (*Aze*) concerning the difference between the two periods, the following statements were given:

(Bu) I am sure there is a difference. My whole attention is taken up with the desire to catch the rhythm (in the first period) and I have only those sensations which help me make that decision, *i.e.*, various kinaesthetic and articulatory sensations; whereas in the other case (in the second period) there is an attitude of satisfaction and verbal ideas meaning 'I can think of whatever I want to.'

(D) I should say that kinaesthesia was decidedly more prominent in the first period. In the first period the affective course is the reverse of that in the second period, *e.g.*, first period, unpleasantness changes to pleasantness; second period, pleasantness changes more gradually to indifference or even unpleasantness with organic sensa-

tions to correspond. There was more effort at attention during the first period. Attention more passive in second period. Auditory sensations are more prominent in the second period. The first period is more interesting and the experience more subjective with the feeling of bodily participation through means of organic and kinaesthetic sensations. There is a feeling of familiarity which comes just at the time of recognition and lasts a little afterwards.

(Ge) Rhythm-consciousness under the second instruction becomes more automatic, which term means a dropping-out of counting, a decrease in clearness, and a wearing-off of the affective tone. The rhythm-consciousness of the first instruction is somewhat influenced by the consciousness of the previous period—a lapping over of the consciousness of the previous period into the rhythmical consciousness (perception of sound). The difference between the two consciousnesses is a gradual change. Under the second instruction, I do not know when to begin to introspect, while under the first instruction I do not know where to stop. The main difference is one of degree of complexity and also, to some extent, a gradual change in the attributes of the conscious processes. [Question: Which consciousness is the more complex? Answer:] The first one is more complex. The attributes of the mental processes are at a higher level, *e.g.*, at first they are clearer, more intensive, more extensive, and more pleasant, and they gradually change from more to less. The first consciousness is richer in contents and the contents are of higher degree. The second consciousness is poorer in contents and the contents are of lesser degree. The second consciousness is more automatic.

The results of these preliminary experiments corroborate the above description taken in a *post mortem* manner. They may be summarised by the characterisation of a typical rhythmical consciousness as present under these experimental conditions. We must, however, exercise the greatest care in not giving too much prominence to this 'typical rhythmical consciousness.' It is not factual, but descriptive of a class of rhythmical consciousnesses; as such a class-description it must suffer all the qualifications that obtain under the type of generalisation by the method of approximation. We may say, then, that usually at the beginning there is confusion of some sort, accompanied by a complex of mixed kinaesthetic, and, occasionally, visual and auditory sensations, and by unpleasant affection. The contents of consciousness is full, but it is not orderly. There is little or no pattern. Soon,—and the rapidity with which this change takes place seems to depend, among other things, upon the degree of difficulty of the rhythm and upon the mental set and the physical condition of *O*,—some phase of kinaesthesia becomes prominent and is definitely localised and recognised in the introspection. More rarely, some series of visual imagery comes into the foreground. If these processes come into the focus of attention individually, they are usually followed by a combination of several processes, all more or less equally prominent, and all

well-ordered and recognised as forming a pattern. Attention is, on the whole, of a high level and discloses a consciousness rich in content. A feeling of strain characterises this high level of attention, and the rhythm becomes definitely fixed in perception. A feeling of satisfaction now ensues, and the affection is reported as pleasant. Should the rhythm be more than moderately difficult, and should it, therefore, not become definitely fixed, or should the mental set of *O* be such that he can not make the rhythm 'fit in,' then pleasant affection may never be reported, and strain-sensations may continue in a vague degree until the end. This was actually the case with some of the odd and infrequently heard rhythms used in the experiments. Then, ordinarily, sensations of strain gradually die away, attention drops in level, kinaesthesia grows less intensive and extensive, and finally vanishes completely or becomes irrelevant to the rhythm. The rhythm is heard merely in terms of auditory perceptions. All kinds of associative ideas may now come into consciousness, but, in the experiments with the 'degeneration' of the rhythmical consciousness, they, too, disappeared. Affection changes gradually from pleasantness to indifference and sometimes to unpleasantness. The rhythm is occasionally reported as 'boresome.' At the extreme duration of one minute in the 'degeneration'-experiments, we found a consciousness almost barren of content, characterised as 'drowsy' and 'sleepy.' The introspections were, as a rule, very brief. As a matter of fact the *O*'s were about ready to fall asleep and often said so. Indeed, consciousness strongly resembled that in the preliminary stages of hypnosis.

This description is based upon facts collected from the preliminary reports of the *O*'s. The evidence is clear and definite, and as far as the typical description goes, it is free from conflicting statements in the introspections of the several *O*'s. But, owing to the preliminary character of the series, the inadequately controlled physical conditions, and the lack of training on the part of the *O*'s, the results so far obtained demanded more substantial corroboration. For this reason we isolated the physical attributes of tonal stimuli as duration, intensity, and pitch; we trained our *O*'s by means of a long series of judgments and introspections; and we shaped our instructions to cover the special points of attack.

*B. Main Series.*—The following are extracts from the reports of *O*'s under the first instruction in the series (*B1 a*):

(D) Trochaic rhythm as before. It began at once but did not seem so markedly a rhythm as before. Breathing (inspiration for long, expiration for short) corresponded. This was my natural rate,

therefore it did not help the rhythm materially. Kinaesthesia of counting 1 . . . 8 or more at the beginning to help the rhythm—I believe to give it more body. Rather monotonous affair. At about the 8th group, noticed a tonal difference and began saying 're, ti,' etc. Verbal idea, with kinaesthesia giving it meaning, 'All this is rather aloof from me,' *i.e.*, from the auditory part of my experience. Kinaesthesia was subjective; auditory sensations localised outside, to the right. Some kinaesthesia of eye-movement (?) which corresponded to the duration of the members.

[*Rhythm: .5", .05"*].

Measures not sharply marked off from one another. In my schema there was no break. Schema: kinaesthetic sensations from eyes which would go as visual schema, but it was not seen as such. Some kinaesthesia in throat of counting 1 . . . 8 (and on ?) with overlapping 're, ti.' Then slight head movement, up for high, down for low, accompanied this.

[*Rhythm: .5", .05"*].

Distance between members of a rhythm not as long as that between measures. Recognised this as objectively true because of lack of exact correspondence with breathing. Tendency to hurry up one phase of breathing and retard the other. This was slightly bothersome.

[*Rhythm: .4", .2"*].

Slight tendency of visualisation of two members as flat thick lines with short distance between them and an implication of a long distance on either side. Lines were seen only two at a time. Kinaesthesia of this more marked than visualisation. Fixation in front. Feeling of balance for the two halves of the measures conveyed by equal intensity and duration of the members and the similarity of the kinaesthesia for the two, although the first was visualised to the left and the other to the right; kinaesthesia was directed correspondingly. Not very marked kinaesthesia located in upper part of trunk, a little throat-kinaesthesia, vague and indefinite.

[*Rhythm: .05", .5"*].

Attentive attitude and fixation as before. Qualitative difference in pitch—first higher. Throat-kinaesthesia and auditory imagery corresponding to the quality of the tone. Another long interval and a repetition of the same. Then experience began to be rhythmical—although, perhaps, made so by subjective experience: breathing with an effort to bring the two together. There was also vague kinaesthesia, organic sensations, and some eye-movement (which was important). Toward end there was a trochaic rhythm with very long intervals—ready to break apart at the slightest provocation. Experience slightly unpleasant—so much of a bother—I was set to get the rhythm at all costs.

[*Rhythm: .45", .1"*].

(E) Auditory sensations—not very clearly perceived at first. Following first auditory sensation there was a conscious complex which I do not analyse [analysed later: there was doubt in regard to rhythm which was carried by kinaesthetic sensations located (?) in neck, body, and limbs with slight contraction], but which carried the meaning: 'what is the rhythm,' or 'I want to know what it is.' At about this time kinaesthetic sensations located in neck, back, and head, from nodding with the rhythm. Also at this time, or immediately following, kinaesthetic sensations in throat, tongue, and lips as if from incipient singing of tones. After-images from tones, very vague, if at all; memory-image of each couple held over from end of one stimulus to the next.

[*Rhythm: .5", .05"*].



At about 3rd group, perception of rhythm, accompanied by pleasant affection and ideas meaning: 'I have caught the rhythm,' 'it goes easier now,' and with following groups as they came there was a perception of the rhythm and recognition of each following group as being like the 3rd group just recognised. [*Rhythm: .5", .05"*].

Attention good throughout the series and tones were in the focus of consciousness. All other contents were much more marginal. There was one fluctuation—this occurring in the interval between the 2nd and the 3rd group, and in this interval there appeared for a moment, very near to the focus of consciousness, kinaesthetic sensations (including general bodily sensations, mentioned above) and perception of comfortableness (not analysed).

[*Rhythm: .25", .25"*].

Both were equally long; this came with the second sound and the perception of the rhythm, and was carried in terms of kinaesthetic sensations which were rather unpleasant. There seemed to be some slight strain-sensations among these. At the same time came ideas (kinaesthetically carried?) which conveyed the meaning, not definitely outlined or worded: 'these tones are fainter and lower in pitch and I can't reproduce them myself as easily as I could the others.' Slight interval. Perception of second group. Perception that these were slightly more intense—due to kinaesthetic sensations from ear. Perception that these sensations formed a group like the first. Unpleasant affection. Unanalysed complex—surprise, vexation, and hesitation. During this time slight strain-sensations in chest, neck, and throat aroused by changed breathing and attempting to reproduce tones internally. Kinaesthetic sensations were quite prominent throughout the period. Toward the end, idea, carried verbal-kinaesthetically, 'I don't like this so well.' [*Rhythm: .25", .25"*].

(G) Knowledge that this sound is the same in intensity, pitch, clearness, and duration as that of the first member. Then same kinaesthesia of muscular tension. Organic sensations pleasantly toned. Pressure sensations of position. Organics. Pressure sensations and sensations of muscular tension were always blended throughout but there were different degrees of blending. Interval following was longer—carried organically. All of this repeated to the end. After the second member of the first group, visual imagery came into consciousness, represented by: [here figure was drawn showing series of black dots, growing more heavy and thick as series progressed, and arranged in a line ending with the heaviest dots to the right]. Line tilted at an angle greater than 90° to the plane of vision. These dots were light and the background black.

[*Rhythm: .25", .25"*].

Auditory sensations of first member in focus. Sensations of general muscular tension. Strain-sensations in left ear and head. Organic sensations very slightly pleasantly toned. Pressure-sensations, *etc.*, of my position. Auditory sensations (or imagery?) faded away and sensations of muscular tension, organics, and pressure-sensations present during interval. Consciousness was at a lower level. Auditory sensations of second member, and knowledge that this was longer, clearer, and more intense (pitch: higher?), carried in organic sensations. This was in focus. Sensations of general muscular tension. Strain-sensations in ear and head. Organic sensations pleasantly toned (slightly different from those corresponding to first member?). Pressure sensations of my position. Interval, during which strain, pressure, and organic sensations were present

(longer than the interval between members, carried organically ?). All of these processes repeated exactly in the same way to the end.  
[*Rhythm*: .35", .15"].

We already begin to note the prominence of kinaesthetic factors in the rhythmical perception, but in the reports of both D and E most of these factors have to do with the initial perception, the 'getting,' of the rhythm, and give place to purely auditory patterns when the 'fitting-in' of the rhythm, or what D describes as giving it 'body,' has been accomplished. G, who is apparently more organic in type, has the kinaesthetic factor present in varying degrees throughout the period; but she, too, distinguishes between the general muscular components and the strain sensations which shift about during the period and undergo various 'degrees of blending.' It is difficult to tell what reference all these changes in the texture of consciousness bear for her, because she seldom reports 'meaning;' yet, from a consideration of her descriptive statements, it is evident that kinaesthesia is most often connected with a judging attitude, *i. e.*, with the estimation of durational, intensive, and qualitative peculiarities of the tones and their intervals. We find, however, with all the prominence given to kinaesthesia, that other complexes come into consciousness, especially near the end of the period when the rhythm has been 'caught.' All of the O's report visual imagery; some report pure auditory complexes without kinaesthetic accompaniments.

Since it was the aim of the series to present a purely durational rhythm, and since from the introspections given it was clear that this object had not been attained on the conscious side in that all of the O's reported pitch and intensity, a series of instructions, *Bi b*, and *c*, were given in order to cancel this tendency on the part of the O's. We find, then, that when the instructions, which called for a fractionation of consciousness into three periods, were given to the O's, there was a much greater uniformity of report on the durational factor alone.

If we consider first the reports given for the period lasting from the 'ready' signal to the perception of the first sound, we find again that kinaesthesia centers around the instruction:

(D) Kinaesthesia in head particularly around eyes which meant a vague realisation of *Aufgabe*. Bodily posture more rigid and strained than times without this *Aufgabe*. Eyes turned toward right ear—attitude meaning expected sound coming from that direction. Breathing slightly strained—result of a new *Aufgabe*. Affective tone perhaps slightly unpleasant—meaning bother with new *Aufgabe*.

[*Rhythm*: .08", .34"].

Rather strained bodily posture. Strain-sensations in trunk and top of head. Eyes turned to right. Kinaesthesia around them meaning: vaguest flicker of realisation of *Aufgabe*. Vague visual imagery of apparatus at my ear. Affective tone rather unpleasant. Trunk-kinaesthetic strains increased. Then sounds came in terms of auditory perceptions. [Rhythm: .3", .1"].

(E) Cutaneous sensations from pressing button. Then dark visual background which was large and into which there came slowly visual imagery of speaking-tube. Then visual imagery of table changing into visual imagery of other room and *E* seated. Next, conscious complex, mostly kinaesthesia, meaning: *E* is giving me a fairly long interval before the tones. Instructions appeared dimly in kinaesthesia. Perception of what I had to do—understanding of it—carried in kinaesthesia. [Rhythm: .3", .1"].

Tactual after-image from pressing button. Visual after-image from light—these faded. Dark visual background. General bodily sensations in chest and different parts of body from pressure of clothing, chair, etc. Visual imagery of *E*'s room, *E*, and apparatus. Some expectation carried probably entirely in kinaesthesia. Slight strain-sensations which came from attending to (listening for) sounds. [Rhythm: .22", .1"].

(G) Sensations of general muscular tension. Respiratory sensations—holding breath slightly. Strain-sensations in ears and head. Sometimes vague visual images of 'pitch,' and 'intensity' (as if written), and something else which stood for 'duration' (?). All these formed an expectant attitude of what I was going to do, i.e., the *Aufgabe*. At very lowest level of clearness—just barely conscious—a confused mass of organic sensations—all 'muddled up.' All processes above mentioned were present during the entire period—excepting visual imagery which came only a few times. They were, however, varying in degrees of clearness, e.g., strain-sensations in ears were very clear—sometimes sensations of general muscular tension. [Rhythm: .3", .1"].

In comparison with this sort of description, we find that a report of the second period, from the perception of the first sound to the perception of the rhythm (instruction *B I e*), shows a different pattern of consciousness:

(D) Was set for a two-membered rhythm (I infer this). Sounds localised to right and in front—to right of right ear. Bodily posture quite rigid and alert. At first sound there occurred a certain complex of kinaesthesia (especially around eyes) which meant anticipation of rhythm as trochaic. This anticipation was in terms of estimation of particular amount and intensity of strain which accompanied auditory sensations. Then came second sound which confirmed my decision—confirmation in terms of relative amount and intensity of kinaesthesia. Then attitude of assurance—in terms of deeper, freer breathing, tendency to expand chest and to hold head straighter. Rather pleasant. [Rhythm: .26", .14"].

A lot of eye-movement with corresponding sensations in neighborhood of eyes which meant a comparison of sounds for duration in terms of eye-strain. A comparison, too, of throat-kinaesthesia which accompanied sounds. Experience quite unpleasant accompanying sensations of nausea and tightness in the diaphragm region. Verbal idea, after a while: 'of course, that was a trochaic rhythm.' Then

verbal idea: 'you have only compared the duration.' Then more eye-movement which meant a comparison of intensities of kinaesthesia.

[*Rhythm*: .22", .22"].

(E) Perception of first group. Slight strain-sensations. Feeling of doubt carried probably by strain-sensations. Perception of second group. Recognition of them as a kind that had been given before. Then judgment followed in words 'short, long.' Next group, words repeated in internal speech. Judgment 'equal' was made for intensity and for pitch—came by kinaesthetic sensations especially in neck and head (nod of head) which were equal.

[*Rhythm*: .22", .22"].

Perception of first member, second following, and then perception of group. First was perceived. Then some unanalysed background processes which I do not now analyse. Perception of second with perception of each being equal in pitch and in intensity. Judgments of these not given in the same way—not same processes in one judgment as in another: one, spoken in internal speech, another, kinaesthesia carrying the meaning. Experience of this experiment (*Aufgabe*) does not run easily yet. Strain-sensations in face and from body, especially from changed breathing involved in listening to tones and in trying to make judgments.

[*Rhythm*: .3", .1"].

(G) Second longer in duration. When I passed my judgment I felt that if the second had been equal in duration, judgment of pitch would have been made more certain—carried in organic sensations. Also felt rather unpleasant when I felt uncertain about pitch and intensity—accompanied by strain sensations. Carriers of rhythm: kinaesthesia of body (in trunk) and respiratory sensations tending to keep time with rhythm. . . . Carriers of rhythm were always in upper level, but varied somewhat in degree of clearness with the exception of two or three times when I was trying to get a final judgment on intensity and pitch. These times I made a supreme effort. Then strain-sensations and sensations of general muscular tension characterise, and the carriers of the rhythm were out of consciousness.

[*Rhythm*: .04", .38"].

In general, in this period, kinaesthesia clusters about the clear perception of the rhythm, the 'carriers of the rhythm,' and also about the judging complex. It has changed in meaning from that which it bore in the previous period, *viz.*, the comprehension of the *Aufgabe* and the expectation of the rhythm; it is often the same sort of kinaesthesia, connected with movements of the eyes, breathing, *etc.*, but it is recognised as referring to something else. Throat-kinaesthesia seems to play a prominent part in the judgment and realization of the rhythm, as well as general strain-sensations indefinitely localised or general throughout the body. In some cases visual imagery also plays a rôle.

In the last period, however, if the judgment has been properly passed, most of these kinaesthetic complexes relax, become less clear, and less intense. If, as in G's case, kinaesthesia persists, it may become irrelevant to the rhythm.

The entire pattern of consciousness becomes different while the rhythm is still present in perception:

(D) Throat-kinaesthesia at first. This soon died away. Auditory experience left to itself. Almost went to sleep. Interesting only at first. Pleasant throughout. [Rhythm: .12", .3"].

Bodily posture relaxed—no accompanying kinaesthesia. Affective tone indifferent or mildly pleasant; began to feel drowsy. After a while sounds became provoking—intruding upon a relaxed consciousness—unpleasant organic sensations. Strong inclination to shake head—to get them off (incipient kinaesthesia). Unpleasantness increased but intermittently so. At times the sounds did not bother so much as at other times. [Rhythm: .08", .34"].

Bodily posture relaxed. Throat-kinaesthesia much reduced, then died away gradually. Respiration ceased to correspond. Eye-kinaesthesia continued for a while much less intense. Began to have achy sensations in ears. Affective tone changed from indifferent to positively unpleasant. Increasing irritated feeling. Sounds seemed to force themselves upon me—I couldn't escape them.

[Rhythm: .08", .34"].

(E) Clearest contents of consciousness were the auditory sensations, and there were also general bodily tactual sensations. Very soon a great number of visual images appeared—images of people around the laboratory and the rooms of the laboratory, especially this room [dark-room]. Clearness of auditory sensations changed from time to time—once or twice they became marginal. Visual imagery changed quite rapidly, and there appeared from time to time repetitions of judgments—they were now all made in terms of internal speech. There soon came a comfortable feeling, rather of an enjoyment of the situation. Strain-sensations prominent in attention became slightly less, especially sensations in face, over the eyes, and in chest,—some also in arm and hands. There seemed to be no visualising of tones as I have noticed before—all auditory. There were also from neck and head (from nodding of head). This meant that I was satisfied with the judgments I had made; that judgments were correct and that I need not attend quite so closely for the purpose of making a judgment. . . .

[Rhythm: .25", .14"].

(G) Verbal idea: 'Now I have found out what the rhythm is; I will just give myself up to the thing.' [Rhythm: .3", .1"].

Throughout the experiment, auditory sensations from tones in receiver with weak sensations from breathing (I tried to keep time) *plus* kinaesthesia in trunk—locality abdominal and above abdomen—also pleasant. Accompanying these, during the first part of the period, fairly weak sensations of general muscular tension. These gradually got fainter and disappeared—their place being taken by general relaxation during which general bodily kinaesthesia became clearer and more intense, and those of keeping time also became clearer and more intense—I mean the sensations of breathing.

[Rhythm: .25", .14"].

At first part of third period, sensations of general muscular tension, located principally in head and trunk—these gradually got fainter and less clear until they disappeared and a feeling of relaxation took their place until the end of the experiment. Feeling of relaxation became more intense—rather soothing. Then, auditory sensations of tone, and these were accompanied by general trunk kinaesthesia which was

pleasant. Kinaesthesia located principally in region of abdomen and above abdomen. This kinaesthesia, as the period progressed, became less clear and intense, and shifted. [Rhythm: .12", .3"].

G has, however, much more kinaesthesia accompanying the rhythm throughout the entire period than have the other O's. While there is a marked shift in pattern of consciousness, with accompanying shifts in the relative intensity, clearness, and modality of the processes, and while there is a decided change in the meaning which kinaesthesia bears, *i.e.*, a tendency to mean 'relaxation,' a great deal of kinaesthesia from breathing survives and accompanies the rhythm. E, however, noticed that G was never as sure of her judgments as were the other O's. If, therefore, a doubtful attitude was taken in this period, G never assumed a passivity of the sort experienced by all of the other O's throughout the entire experiment. She says, for example:

Intensity, pitch, and duration equal. This settled fairly quickly, but continued to judge intensity until near the end—to make sure.

[Rhythm: .22", .22"].

When the last period was lengthened to one minute, the facts above mentioned in connection with the observations were verified. That the results obtained in this 'fractionated' series are not rendered invalid by this method of 'fractionation,' can be assumed from the comparison of these results with those that were obtained when the period was not subdivided.<sup>64</sup> All of the results given are in agreement, with the possible exception of G's observations, for which a special hypothesis has been advanced.

To continue with the results obtained in series B2, in which a rhythm was produced in terms of physical differences of intensity, we find further confirmation of the above facts. Since these confirmations were obtained under new conditions, they may be quoted. Under the first general instruction B2 a, we get introspections such as the following:

(D) Acted under *Aufgabe* to judge duration first. Comparison of duration in terms of throat-kinaesthesia accompanying the two sounds, which was in turn measured in terms of eye-kinaesthesia, *i.e.*, throat-kinaesthesia accompanying each sound was accompanied by a certain amount of eye-movement which corresponded in length to the duration of the sound. There may have been slight visualisation of throat-kinaesthesia as two gray bands. Visual part very slight, chiefly in terms of eye-kinaesthesia. That for the second sound was longer

<sup>64</sup> The O's were asked to give an estimate of the 'completeness' and 'accuracy' of their introspections on the basis of 100%. None of the estimates given were below 80% for either one of these; most of them ranged from 90%-100%.

than that for the first, therefore judgment that the second was longer. Judgment repeated itself three or four times automatically. Next judgment one of pitch. Two sounds were localised (visualised ?) in correspondence with their pitch. First sound localised above second—judged higher. Throat-kinaesthesia involved somewhat. Repetition of first two judgments 'longer and lower.' For third judgment, kinaesthesia of throat was measured for intensity. In correspondence with intensity of throat-kinaesthesia—visualisation of two sounds as rounded figures, first to the left of second. First seemed to stand out more (in third dimension toward me) but there wasn't very much difference between them. Finally made verbal decision.

[*Rhythm: 1 > 2*].

(E) Perception of first tone and imagery present became dim, tone becoming clearer. Slight organic shock as attention turned from imagery to sensational complex. Tones perceived merely as tones for a moment or two—no judgments being made as to rhythm. Then suddenly words 'long, short' spoken in internal speech accompanying the realisation that these tones seemed to be very much like memories of other 'long, short' series. This was not a judgment. Judgment on intensity was made kinaesthetically—a stronger contraction, tension for first, less for second. About this time judgment as to duration was made [equal] merely in terms of slight nod of head which meant 'equal.' Some confusion like inhibition of judgments—strain-sensations were present. Finally pitch judged by a nod of the head—this carried judgment 'same.' Complex of bodily sensations throughout the experiment, partly from change in breathing.

[*Rhythm: 1 < 2*].

(G) Sometimes I just gave myself up to the rhythm; at these times, auditory sensations of tones, a kinaesthetic swing of the trunk with each auditory sensation, pleasantness, and a general muscular feeling meaning relaxation would be in a cross-section of consciousness. This 'giving myself to the rhythm' occurred at the first only: during the latter half I judged intensity, pitch, and duration. Then there were marked strain-sensations in ears, and a general feeling of strain,—rigidity.

[*Rhythm: 1 > 2*].

In the series of fractionations which followed, *B2 d, e, and f*, we obtained such introspections as these for the first period:

(D) Assumed usual position, eyes turned toward direction of right ear. Expectation in terms of kinaesthesia of head and eyes that sound would come from that region. Otherwise performance quite automatic—no *Aufgabe*. My actions were all automatic.

[*Rhythm: 1 > 2*].

(G) Strain-sensations in region of ears, forehead, and eyes; kinaesthetic and pressure sensations from breathing, meaning *Aufgabe* in general and expectancy of the rhythm (part of the *Aufgabe*) in particular.

[*Rhythm: 1 > 2*].

For the second period, we have:

(D) First auditory sensation compared in terms of kinaesthesia of head, eye, and throat. There were unpleasant organic sensations. Feeling of perplexity—this lasted quite a while—at same time verbal idea: 'I wonder if the first member is really longer or shorter than the second member.' This in terms of kinaesthetic attitude. Before this a perception of grouping in rhythm. Second member higher.

Idea, chiefly attitudinal, 'whether it seems longer because it is more intense.' Comparison of amount of strain accompanying each sound for duration. Sometimes second longer than the first; sometimes first longer. Final decision, probably equal in duration; second is equal or longer. Intensity, second weaker. Unpleasant coloring in terms of organic sensations throughout the period.

[*Rhythm: 1>2*].

Characteristic of the last period is this description:

(E) Repetitions of judgments in terms of kinaesthetic processes, in nods very largely, not clearly in speech. Attention to tones not so good as before; general bodily sensations especially from breathing. Pleasant affective tone becoming clearer—seemed to occupy consciousness more fully with the tones. Occurrence of question in terms of verbal-kinaesthesia, 'Was I right?' Then a re-judging of the rhythm. Then assurance of the correctness of the judgment of the rhythm. Again attention much poorer on tones. Much pleasanter affective tone occurred with general bodily sensations. Sensations from change in breathing. Reappearance of *Aufgabe* inattentively in consciousness; words in internal speech in regard to judgment arose from time to time. At one time, visualisation of tones as spots to left—in front of me—one being more conspicuous than the other. Nothing else that is of any importance—nothing that I can recall. Consciousness not very rich, not nearly as rich as consciousness in previous period.

[*Rhythm: 1<2*].

These data further establish our conclusion. Kinaesthesia in the first part of the period carries the meaning of expectancy and the *Aufgabe*; consciousness is, however, not rich in processes, nor complex in pattern. When the rhythm is first heard, kinaesthetic strains, muscular contractions in head, throat, neck, and the other parts of the body, appear as references for the interpretation of the rhythm and as aids to its clear perception; consciousness is rich in processes of several modalities,—visual, auditory, kinaesthetic complexes come in. Gradually, a large part of these kinaesthetic processes disappear; a few may remain; some may become associated with the meaning of relaxation. Irrelevant imagery may appear, verbal ideas may arise; but, in general, consciousness again becomes relatively poor in contents, and less clear in attention. All of these facts were more emphatically brought out when the entire period was lengthened to one minute (*B2h*). We were interested in the question how much kinaesthesia would be present in the rhythmical consciousness when the condition of passivity was insisted upon by *Aufgabe*. For this reason we gave D instruction *B2g*. Under this instruction she says:

(D) Fixation and passive attitude as before. Deep, full breathing with some attention on that as well as on right ear—lazy feeling after a few seconds—then sounds came, localised in right ear. First one longer and louder than second—fairly smooth and rather musical.



Immediate acceptance of trochaic rhythm. Vague bit of kinaesthesia chiefly in head, in eye-region, somewhat in terms of respiration, *i.e.*, breathing became more easy after acceptance. There was involuntary throat-kinaesthesia accompanying each sound, really a repetition of each sound as it came. Part of time remained passive but after a while attention wandered from sounds in my ear to kinaesthesia in my throat. A comparison of throat-kinaesthesia accompanying sounds in terms of their intensity and also intensity of eye-kinaesthesia accompanying throat-kinaesthesia. Then verbal idea: 'you are not following *Aufgabe*, you should relax.' This was followed by readjustment of bodily posture, decrease of throat-kinaesthesia. Then later, verbal idea, chiefly attitudinal: 'the rhythm seems much more alive when there is throat-kinaesthesia. It seems rather monotonous without it.' Affection indifferent. [Rhythm: 1>2].

With a change in two of our three *O*'s, and with our apparatus altered to give differences in pitch in the objective sounds produced, we pass on to the next series of introspections. As the result of fractionating the entire period, we obtained characteristic introspections of the first period, of which the following are abstracts:

(B) Strong, clear, tactual-kinaesthetic sensations from hand and forearm (pushing button), overlapping temporally auditory sensations and ear-strain *plus* eye-movement sensations (mean sound of buzzer with slight effort to hear it). Followed by a considerable period characterised by kinaesthetic sensations in head, like a very faint dizziness *plus* slight eye-strains *plus* visual sensations of very dark, uniform, black field (means blankness, nothingness, a sort of unconscious expectancy). Followed by kinaesthesia in chest—strong, means: 'oh, I must listen for the rhythm.' Interval. Followed by auditory sensations *plus* visual imagery of *E plus* eye-strains (means *E* walking heavily on floor). Followed by sensations—conscious attitude, perhaps,—means: 'no, that isn't *E*; it's someone pounding.' Very fleeting. Followed by interval characterised by expectancy, impatience. I do not remember content. Quite unpleasant; somewhere in the interval I wondered whether anything had gone wrong and the rhythm wasn't going to come; also thought how long the period was; also wondered if I could ever report it all. These things came up with prominent kinaesthesia and a little visual imagery, generally accompanied by eye-strain. There may have been slight verbal tags. I cannot, however, remember the content in detail.

[Rhythm: *a#*, *d'*].

(F) Pressed button, turned eyes toward left ear. Strain-sensations begin and continue throughout the period. These strains are localised especially in abdomen, though somewhat less intense strains in chest, arms, neck, and face. The abdominal strains seem to color the entire experience slightly unpleasantly, especially after I have waited a little and the sound doesn't come. Very vague auditory imagery of a sound and auditory verbal imagery: 'pitch,' 'rhythm,' during the period.

[Rhythm: *d'*, *a#*].

(G) Pressure and muscular sensations in right hand from pressing button. Then mass of kinaesthetic sensations from trunk, upper part principally, and at times taggy very unclear auditory-verbal kinaesthesia, all standing for the instruction. Then strain-sensations in

left ear-region and some other unanalysed organic sensations—forming expectant attitude of what was to come.

[*Rhythm: c', a#*].

For the second period, we have the following descriptions:

(B) Auditory perception of first member. Followed by strong kinaesthesia in arms, trunk, and head (means: adjustment to situation and effort to attend to sounds). I think above was accompanied by unclear kinaesthetic sensations in chest (meaning: expectancy of second member, sort of anticipation of the two-rhythm). Auditory perception of the second member, including strong kinaesthesia in body. The second perception came not suddenly but as if anticipated. I think the kinaesthetic factor was not new, but the old anticipatory kinaesthesia became clearer and probably intensified. The second member came almost as familiar, although I cannot say that the familiarity was carried by anything more than the kinaesthesia mentioned above, and the whole consciousness was more indifferently than pleasantly toned. After second member there was period of strong kinaesthesia, very different from that mentioned—meaning was uncertainty; I should say now that it was uncertainty as to whether I had yet perceived the rhythm or whether I should still go on.

[*Rhythm: a#, c'*].

(F) First two sounds which came to me formed a rhythmical foot this time. In period of waiting for sound to come, I had talked to myself, something like this: 'there is really a rhythm coming, maybe it will be like the last.' Turned eyes toward ear, strain-sensations, auditory images of rhythm to come ('high, low') as in last experiment. Now when sound did come it was high like the last, and I think I held my breath, or at least the strains in the upper part of my chest and face kept steady, as if I were expecting the second part of the rhythmical foot (steady strains in abdomen, chest, eyes, and face are signs of expectation of sound in the first period. 'Steady' does not mean steady in intensity and clearness, but in duration). Now when the first sound came I think the abdominal strains decreased or disappeared this time while the other strains of the fore-period did not till after I had at least gotten a first foot.

[*Rhythm: d', a#*].

(G) Auditory sensation, then another auditory sensation. Accompanying the second, unanalysed organic sensations—principally in trunk, meaning slight surprise and a 'stutter.' Then auditory sensation of first member, then auditory sensation of second member, accompanied by unanalysed organic sensations meaning: 'not so much difference in pitch.' Then unanalysed sensations (organic) in trunk meaning: 'judge as soon as possible.' Again auditory sensations of first member and auditory sensations of second member, accompanied by unanalysed organic sensations meaning: 'second slightly higher in pitch.'

[*Rhythm: a#, d'*].

The reports for the last period follow:

(B) Period was very long and I cannot more than indicate its general form—mostly in *Kundgabe*. . . . Later a very long period in which rhythm was in unclear consciousness. This was a period of waiting for the sound to cease. The prominent thing in it was eye-pressures and strains. Many clear processes of note-taking—e.g., visual images of the eye-pressure, meaning: 'that's

what's in consciousness now.' Organic processes from all over the body would become clear at times and then fade away, leaving the eye-pressures again (these were not the usual eye-movement strains). I can describe the whole period as one of restlessness and impatience for the period to end, with growing unpleasant affective tone. . . . Later period in which I remembered that I probably ought to report pitch differences. Now high tone came into clear consciousness, clearer than low. I seemed to take it analytically in an attempt to describe it. It seemed particularly pervading and granular, rather compressed and thrusting—these are all really meanings of other processes in consciousness, principally visual imagery and ear-kinaesthesia. [Rhythm: *d'*, *c'*].

(F) Attention after this wandered from sounds in receiver to other sounds. . . . I talked to myself: 'why doesn't he shut it off?' 'period is long,' etc.

[Note: F, left to himself in this period without any definite task, devises little problems and experiments with subjective shifting of the accent regardless of its objective fixation. In a number of introspections he describes this process in detail. In the prominence of kinaesthetic strains that are called forth with this effort, his consciousness thus described is very similar to one which E once reported when, under the instruction with full knowledge, he was told that a certain form of rhythm was forthcoming, though, because of a slip in E's technique, its direct opposite was produced! Strain and other kinaesthetic sensations forced a subjective rhythm into consciousness by suggestion from the instruction, in direct opposition to a marked objective form.]

[Rhythm: *d'*, *a#*].

(G) With each auditory sensation at first a slight kinaesthetic swing of trunk from left to right with a feeling of general relaxation in terms of general muscular sensations *plus* pleasantness. Kinaesthesia disappeared, relaxation grew more and more distinct, auditory sensations less clear. Then a mass of organic sensations (unanalysed), meaning: 'suppose I must judge duration and intensity.' Then a mass of muscular sensations *plus* unpleasantness, meaning: 'effort to judge.' Judgments carried by unanalysed organic sensations. After judgments, visualised 'duration.' Then relaxation gets more and more distinct again; pleasantness present; auditory sensations less distinct also—they had gotten more distinct during judging. [Rhythm: *a#*, *d'*].

Several O's had frequently referred to sensations of respiration in their observation; D had repeatedly noted that her respiration kept time with the rhythm; E, F, and G are conscious of breathing sensations when they are judging the rhythm. It is, in general, inconceivable that the rate of breathing could have corresponded with the rhythm as it was reported, *i. e.*, in its simple form, because a reference to the account of the apparatus will show that the rhythmical cycle was uniformly executed in 2 sec., while the average rate of breathing of the O's tested was about 3.75 sec. for the complete cycle: no O ever breathed more slowly than one cycle in 5.7 sec. or faster than one cycle in 2.7 sec. That respira-

tory sensations carried meanings is factual, and, from the theoretical side, plausible. The curves for all the *O*'s tested show a retardation of rate in the period before the rhythm is heard, but no marked variation from the normal rate after that; *i.e.*, there is no uniform change in the rate at any definite place in the period outside of the one described, and the variations during the entire period are not noticeably different from the variations in the corresponding normal curve. Instances to illustrate this fact, taken at random from typical curves, are: a normal curve on a given day gives an average rate for B of  $4.04'' \pm .34''$  during a rhythm following this it is  $4.08'' \pm .14''$ ; for F, normal  $4.04'' \pm .77''$  rhythm-curve  $4.01'' \pm .096''$ ; for G, normal  $3.47'' \pm .1''$  rhythm-curve  $3.35'' \pm .17''$ . It is evident, then, that whatever significance respiration may have on the conscious side, physically there is no ground for belief, on the basis of some fifty kymographic records of the rates of breathing during rhythmical perceptions, that there is actual physical correspondence between this rate and the rate of the rhythm perceived.

We tried the effect of attempting to rule out, by means of an instruction (*B<sub>3</sub> x*), the conscious presence of kinaesthesia during rhythmical perception.<sup>65</sup> These are our results:

(B) Uncertain whether there was relevant kinaesthesia or not. I felt before starting that I did not know what to do to inhibit kinaesthesia,—that if the instruction did not work automatically, I should be helpless. During fore-period verbal imagery (auditory-kinaesthetic) kept coming up: 'no kinaesthesia,' 'don't,' *etc.* Intense chest-strains and strains (vague) in arms and legs, all meaning resolve to inhibit. Auditory perception of first member was followed immediately by increase of chest-strains and general bodily tenseness, meaning: 'now,' 'don't get kinaesthesia.' . . . Perception of second member was at first purely auditory. Then it became a complex with other processes meaning: 'this is different'—from first member. Most prominent was visual imagery of a black and white streaked, almost formless thing, floating a little below and to the left of center of visual field meaning second member. The blackness of the image meant 'this is blacker than No. 1' thus carrying the distinction. . . . I should say the order of clearness was: clearest, first auditory sensation, then visual imagery; less clear, but quite clear, kinaesthesia relevant to effort to inhibit kinaesthesia relevant to grouping; unclear, kinaesthesia relevant to grouping, if present, and auditory sensations after visual sensations had appeared. . . . In general the effect of the *Aufgabe* was to make the experience very kinaesthetic in that whatever processes there may have been relevant to the grouping came upon a very complex background of fairly clear kinaesthesia. The experience was unusually kinaesthetic,—perhaps, less relevantly kinaesthetic. [*Rhythm: d', c'*].

<sup>65</sup> This instruction is similar to *B 2 g, q, v*.

(F) Lay back passively at first. But again, as soon as rhythm was 'going nicely,' as soon as I was 'in the swing of it' thoroughly and 'felt at home,' I noticed again the tendency of the throat to follow or sing the rhythm. Tried to stop this and did so, though I think it also involved holding breath. Now when throat was tense and I again put full attention on sounds, I found that my head tended to nod forward with accented beat. I simply couldn't prevent it. In résumé, I tried to attend passively, had actively to stop throat kinaesthesia. Then holding throat steady, I would no longer attend passively to tone but had to attend actively. When I began to attend actively, my head began to nod (actually, or in image), and I couldn't prevent it. [Rhythm: *d', c'*].

(G) With first two auditory sensations, strain sensations in head and unpleasantness, meaning: 'scrappy.' Then with the auditory sensations, vague taggy kinaesthesia in throat and slight strain-sensations in temples and head were the constituents of a disjointed talk to myself relevant to the tones. Then bobbed up for a moment a mass of unanalysed organic sensations in trunk meaning: 'I have to judge the rhythm clearly, two successive sounds as a group: no kinaesthesia.' Then just auditory sensations, tones, and a slight feeling of relaxation in trunk and pleasantness and beginning of vague kinaesthesia in front of chest, a sort of pressure inward. Then organic sensations meaning: 'that won't do.' Then very intense strain in top of head, forehead, temples, and also with each tone a pressure in ear, located near ear-drum, if not there. This becomes somewhat clearer. Organic sensations meant: 'that I could be positively certain that they were in groups of two members.'

[Rhythm: *d', c'*].

We note that under the instruction consciousness becomes unusually full of strain sensations and other kinaesthetic complexes because of the effort to inhibit. We also note that in several cases, for moments in the periods of both B and F, a purely non-kinaesthetic rhythm was experienced. The rhythm, it is true, is under these conditions not permanent, nor is it actively perceived as a rhythm; nevertheless, a certain perception of rhythm is possible without kinaesthesia.

We next ventured into an investigation of light-rhythms, again by the method of fractionation (series *L d, e, and f*). All *O*'s perceived a rhythm. The three periods were in contents much what we have described in regard to other series, with the exception that kinaesthesia of eye-movements was very marked in all of the introspections—a result probably due to the extensiveness of the flashes on the screen. Although some of the kinaesthesia did carry the meaning of relaxation in the third period, especially for G, this was of far less frequent occurrence in this series than in any of the others. Otherwise the reports are not sufficiently different from reports of corresponding periods in other series to warrant insertion.

In answer to the 'confrontation-question' put to B, D, F, and G, the following statements were made:

(B) I think, although I am very doubtful, that the fore-period sometimes contained expectation carried in kinaesthesia. I am also inclined to believe that the rhythm was sometimes anticipated and I think that this anticipation was in terms of kinaesthesia. Probably there was visual imagery, too; again I do not remember. I am pretty sure that sometimes in the mid-period the rhythm was perceived before the second member occurred, the second member being carried anticipatorily in some manner,—sometimes, I believe, by organic chest-strains which immediately relaxed or changed as soon as the second member appeared. The change meant, I believe, 'the rhythm is perceived.' Kinaesthesia in the after-period carried impatience for the rhythm to conclude.

(D) As I now remember the experience there was (1) considerable kinaesthesia during the fore-period—in the region of the diaphragm (from rigidity of posture, and slightly inhibited breathing), and around the eyes (from the fixation of the region of the right ear). If the fore-period lasted, there was gradual relaxation with corresponding lowering of kinaesthesia. (2) The first sound of the rhythmical series was accompanied by heightened kinaesthesia, I believe (greater strain of bodily posture). There was a great deal of eye-movement kinaesthesia accompanying the auditory impressions with increased violence of 'diaphragmatic sensations' (constrained breathing) until 'clear perception of the group as a rhythm.' Kinaesthesia of nodding of the head usually accompanied auditory impressions. (3) This clear perception was accompanied or immediately followed by a reduction in amount, intensity, and kind of kinaesthesia. The sensations in diaphragm-region became those that mean easier, fuller breathing; they became less relevant to the situation, and on much lower level of clearness. There was gradual relaxation of muscles around eyes, with corresponding reduction in kinaesthesia. If there had been sensations from nodding of head or trunk in time to the beats, this was gradually much reduced. If the period continued for a long time, the kinaesthesia was ultimately much reduced. If now the period continued *ad nauseam*, there was a new set of kinaesthesia (though visceral sensations predominated). I should not swear that relevant kinaesthesia ever wholly lapsed.

(F) In the fore-period, always or nearly always, I think my introspections will show strain sensations of considerable intensity, of considerable extent (distributed through especially the chest, shoulders, face—especially in eye-muscles—and about the ears). It seems to me that in general these strain-sensations keep up (without any marked decrease in intensity—without alternation of strain and relaxation) until sound is heard. Before the time when the period was divided, certainly I should say that in the fore-period, these strain-sensations were not as intense. When the *Aufgabe* is to introspect from the beginning to the judgment (period 2) my general impression is that the strains in the fore-period were less intense than when the instruction was on period 1. Certainly the sounds are the processes which form the focus of attention; with the coming of the sounds there is a relaxation of the strain. When the sounds are heard, not in a rhythm, there are sometimes, I think, feelings of confusion which are partly kinaesthetic—not so much strain, I think, as muscular and articular—not so definitely localised, not so intense, and

not so clear as are the strain-sensations of the fore-period. The strains in the eye-muscles still persist after the coming of the sounds with little or no decrease in intensity, but certainly with decreased clearness. Let me add: that it seems as though the eye-strain and the ear-strain in the fore-period were fused with the other strain sensations—forming part of the general ‘expectancy.’ They persist at a lower level of clearness. What there is different about consciousness when the rhythm is perceived, is very difficult to say: there is, of course, a lack of ‘confusion.’ The sounds themselves are clearer than when they are heard not in rhythm. Sometimes there is kinaesthesia in the throat which begins when the perception of the rhythm comes, sometimes there is actual or imagined nodding of the head, but I am not sure but that this is true especially when the rhythm is first perceived and that both of these may be lacking and the rhythm be perceived. I am inclined to think that the kinaesthesia in the throat especially is a process which comes in partially or entirely because I have to judge pitch—and also I am not sure but that the nods of the head come in, partly because I formerly had to judge intensity and partly because nods of the head seem in a way to keep the two members of the group more or less apart so that the judgment of pitch is easier. My *Aufgabe*, expressly given by *E* or given to myself with regard to my behavior (conduct after the judgment, period 3), has been extremely varied—therefore not enough alike to generalise.

(G) During the judgment of pitch, intensity, and duration, only weak kinaesthesia was present with each auditory sensation, and sometimes, maybe, not at all (this last point very uncertain). During this time (time of judgment) muscular sensations meaning strain were present; sometimes weak, sometimes intense. After judgment, muscular sensations, meaning relaxation, gradually get more intense and clearer, and then remain at fairly constant intensity and clearness; and the kinaesthesia with each auditory sensation becomes more intense and clearer—gradually, and finally does not vary much. Usually the kinaesthesia is located on one side of the body with the first auditory impression, and on the other with the second. Kinaesthesia nearly always in trunk—though its exact localisation and extent at times (not very often) vary somewhat with or during various experiments. I remember, with some uncertainty, when it was localised in head for part of the experiment (when I did not have to introspect that period). When I had to judge and ‘give myself up to the rhythm,’ kinaesthesia (although varying in intensity and clearness) was, on the whole, more intense and clearer than when I was to judge in the first place.

When allowance is made for individual variations in these reports, our analysis of the typical consciousness does not lack confirmation. It is plain that kinaesthesia shifts both in formation and in meaning through the period.

#### IV. CONCLUSION AND SUMMARY

We have obtained a sufficient number of introspective analyses of the rhythmical consciousness from adequately trained observers, and under the isolating conditions of an

experimental procedure, to make possible what we consider valid conclusions. They are as follows:

1. There is a decided change in the kinaesthetic processes present in a rhythmical consciousness from the time that the first auditory impressions which form a rhythm are heard to the end of the period of the experiment. These processes vary (a) in texture, *i. e.*, there is a substitution of qualitatively different processes; (b) in clearness; (c) in intensity; and (d) in meaning or reference.

2. There may be a perception of rhythm without accompanying kinaesthesia, in terms of (a) visual imagery, or (b) auditory imagery, or sensation.

3. There is usually a marked change in the affective tone throughout a typical period of rhythmical perception, from slight unpleasantness before the rhythm is grasped, through pleasantness when it is thoroughly perceived, to unpleasantness when it continues without change.

4. There are individual variations in the amount of kinaesthesia, in the degree of its prominence, and in the type of meaning of kinaesthesia that corresponds to the rhythmical perception.

5. Generally, kinesthesia is most prominently connected with the initial clear perception of the type and form of the rhythm.

6. Instruction is almost invariably carried in consciousness by kinaesthesia.

We might sum up our main conclusions in a single formula: Under the conditions of these experiments, it proved that, whatever was the material presented for rhythmisation (equal and equally spaced sounds for subjective rhythm; sounds of different intensities; tones objectively varying only in duration, in intensity, in pitch; flashes of light differing in intensity), kinaesthesia was essential for the establishment of a rhythmical perception. That perception once established, however, rhythm might be consciously carried, in the absence of any sort of kinaesthesia, by auditory or visual processes.